The Sheguiandah Site

Archaeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario

Edited by

Patrick J. Julig

103-052587

The Sheguiandah Site

Archaeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario

Edited by
Patrick J. Julig

Mercury Series
Archaeological Survey of Canada
Paper 161

Published by
Canadian Museum of Civilization

© Canadian Museum of Civilization 2002

NATIONAL LIBRARY OF CANADA CATALOGUING IN PUBLICATION DATA

Main entry under title:
The Sheguiandah Site: archaeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario

(Mercury series, ISSN 0316-1854)
(Paper/Archaeological Survey of Canada, ISSN 0317-2244; no. 161)
Includes prefatory material in French.
ISBN 0-660-18755-8

1. Sheguiandah Site (Ont.)
2. Paleo-Indians — Ontario — Manitoulin Island.
3. Excavations (Archaeology) — Ontario — Manitoulin Island.
4. Antiquities, Prehistoric — Ontario — Manitoulin Island.

I. Julig, Patrick John, 1946- .
II. Canadian Museum of Civilization.
III. Archaeological Survey of Canada.
IV. Series.
V. Series: Paper (Archaeological Survey of Canada); no. 161.

E78.O5S33 2002 971.3'135'01 C2002-980092-7

PRINTED IN CANADA

Published by
Canadian Museum of Civilization
100 Laurier Street
P.O. Box 3100, Station B
Hull, Quebec
J8X 4H2

Technical editor: Richard Morlan
Senior production officer: Deborah Brownrigg
Design: Roger Langlois Design

Front cover: Quartzite outcrop at the Sheguiandah site and (inset) a quartzite artifact found there (photos by Patrick Julig).

OBJECT OF THE MERCURY SERIES

The Mercury Series is designed to permit the rapid dissemination of information pertaining to the disciplines in which the Canadian Museum of Civilization is active. Considered an important reference by the scientific community, the Mercury Series comprises over three hundred specialized publications on Canada's history and prehistory.

Because of its specialized audience, the series consists largely of monographs published in the language of the author.

Titles in the Mercury Series can be obtained
by calling 1-800-555-5621;
by e-mail to <publications@civilization.ca>;
by Internet to
<http://www.cyberboutique.civilization.ca>;
or by writing to:

Mail Order Services
Canadian Museum of Civilization
100 Laurier Street
P.O. Box 3100, Station B
Hull, Quebec J8X 4H2

BUT DE LA COLLECTION MERCURE

La collection Mercure vise à diffuser rapidement le résultat de travaux dans les disciplines qui relèvent des sphères d'activités du Musée canadien des civilisations. Considérée comme un apport important dans la communauté scientifique, la collection Mercure présente plus de trois cents publications spécialisées portant sur l'héritage canadien pré-historique et historique.

Comme la collection s'adresse à un public spécialisé, celle-ci est constituée essentiellement de monographies publiées dans la langue des auteurs.

Vous pouvez vous procurer les titres parus dans la collection Mercure par téléphone, en appelant au 1 800 555-5621, par courriel, en adressant votre demande à <publications@civilisations.ca>, par Internet, à <http://www.cyberboutique.civilisations.ca> ou par a poste, en écrivant au :

Service des commandes postales
Musée canadien des civilisations
100, rue Laurier
C.P. 3100, succursale B
Hull (Québec) J8X 4H2

Canada

Dedication

This book is dedicated to the late

Thomas E. Lee,

who discovered and managed to protect the Sheguiandah Site,
and to all the workers who assisted him during the first investigations in the 1950s.

Contributors

Thane W. Anderson
25 Dexter Drive
Nepean, Ontario
K2H 5W3

Peter J. Barnett
Willet Green Miller Centre
Ministry of Northern Development and
Mines, OGS
933 Ramsey Lake Rd.
Sudbury, Ontario
P3E 6B5

Patrick J. Julig
Laurentian University, Anthropology
Department
Sudbury, Ontario
P3E 2C6

Robert E. Lee
R.R. #2
Whitelake, Ontario
K0A 3L0

C.F.M. (Mike) Lewis
GSC Atlantic
Box 1006
Dartmouth, Nova Scotia
B2Y 4A2

Darrel G.F. Long
Laurentian University, Geology Department
Sudbury, Ontario
P3E 2C6

Eva M. McDonald
Archaeological Services Inc.
528 Bathurst St.
Toronto, Ontario
M5S 2P9

William C. Mahaney
Geomorphology and Pedology Laboratory
Atkinson College, York University
4700 Keele Street.
North York, Ontario
M3J 1P3

David A. Robertson
Archaeological Services Inc.
528 Bathurst St.
Toronto, Ontario
M5S 2P9

Peter L. Storck
Curator Emeritus, Department of
Anthropology, ROM
P.O. Box 978
Markdale, Ontario
N0C 1H0

Peter H. von Bitter
Royal Ontario Musuem
100 Queen's Park Crescent
Toronto, Ontario
M5S 2L6

Ronald Williamson
Archaeological Services Inc.
528 Bathurst St.
Toronto, Ontario
M5S 2P9

Preface

The Sheguiandah site is a rare upper Great Lakes stratified Paleoindian and Archaic site, with alleged earlier artifacts in mixed sediments; which were considered glacial till by the original investigator Thomas E. Lee. A final report on the archaeological and geological investigations done in the 1950's was never completed for this site. This book brings together available information on the site, including the re-investigations from 1989-1991, and subsequent research on the site's geological and palaeoenvironmental history. It also resolves the long-standing controversy about the artifacts in mixed "till-like"sediments below Paleoindian points and of the age of this site.

The uniqueness and value of this rare stratified early site was recognized by the original discoverer Thomas E. Lee, who was successful in having the site protected by the Government of Ontario. However, he was not able to complete the investigations, nor fully report on the site. Since work was stopped in 1955 the site remained enigmatic, controversial, and neglected until 1990.

The artifact collections are curated at the Canadian Museum of Civilization, with some at the Royal Ontario Museum, Howland Township's Museum in Sheguiandah, and with several other institutions and individuals. There is no comprehensive catalogue, with only field description numbers on the large artifact collections.

In 1989, the editor started an analysis of the existing collections including the sediment samples, and planned to date the charcoal and other organic samples excavated by Thomas .E. Lee. Funds were obtained from the Ontario Heritage Foundation to conduct AMS ^{14}C dating, but the charcoal and other organic samples proved to be in poor condition and of uncertain context.

In 1990, a suite of the sediment samples collected by Thomas Lee and Bruce Liberty in the 1950s from the Sheguiandah Site "Habitation Area" were analyzed by the editor and Bill Mahaney of York University Geomorphology and Pedology Laboratory. The results indicated that some of the controversial "till-like"sedimentary deposits were mixtures of sand, silt and clay, but underlying strata were sorted sandy deposits. It was not possible to clearly resolve the geomorphic origin of the mixed deposits with artifacts without new investigations, and comparison of these sediments with off-site tills and near-shore lacustrine mixed deposits.

To obtain new samples for ^{14}C dating in 1990, we decided to re-core the small swamps (bogs) on the top of the quarry area on the Sheguiandah Site. Peter Storck was contacted as he previously also expressed an interest in re-investigating the site, and together with Thane Anderson from the Geological Survey of Canada we extracted the cores and Thane performed the pollen analysis.

In 1991, a community initiative by the local municipality of Howland Township and the First Nations of Sheguiandah and Sucker Creek provided the impetus for an archaeological Master Plan, for both conserving heritage resources and developing tourism potential. As part of this Master Plan research, renewed excavations were conducted at Sheguiandah under the overall direction of Archaeological Services Inc. (ASI), a Cultural Resource Management firm in Toronto.

Ron Williamson, the president of ASI, contacted the editor about directing the geoarchaeological aspects of the re-investigations. This included trying to determine the age and origin of the mixed deposits, and site geochronology. Peter Storck was then contacted as he was already involved with us in the re-coring of the Sheguiandah swamp, and other specialists were brought in including geologists Peter Barnett, and Peter von Bitter.

The editor also contacted Robert E. Lee, son of Thomas E. Lee, and invited him to visit the site when the old trenches were re-excavated, in order to conduct new sampling and analysis. Robert was also able to provide his late father's maps to re-locate some of his father's excavations and test pits, as well as other valuable information. Later the editor asked him to write an historical perspective on his father's research at Shequiandah, and to provide information previously unpublished (Chapter 2).

The authors of each chapter have addressed and evaluated the Sheguiandah Site from various disciplinary perspectives. Each chapter is intended to stand on it's own, but the editor attempts to tie them together in the Introduction and in the final chapters, and to provide a geoarchaeological perspective into the Late Pleistocene / Early Holocene human paleoecology of the Sheguiandah site within the upper Great Lakes region.

The analysis of the Sheguiandah artifact assemblages is not fully completed and will require further excavations and analysis by future researchers. The original excavators did not retain all the flake artifacts, and cores and are therefore a technological study of the Sheguiandah quartzite lithic industry based on existing collections would be incomplete. The existing collections are also widely dispersed and those artifacts curated at the Canadian Museum of Civilization are not necessarily a representative sample.

The main objectives of new excavations in 1991 were to resolve the geological issues on the age and origin of the controversial mixed deposits, and to determine the limits of the site with respect to the area designated by T. Lee, and not to provide major new archaeological collections. The detailed objectives and methods are explained in Chapters 1 and 3, which also includes the First Nations view's with respect to their traditional-use sites in the area. However, as part of this research much new archaeological data about Sheguiandah is obtained, along with a better understanding of the culturally diagnostic materials such as the points, which are analyzed by Peter Storck.. The more technical geological, palaeoenvironmental and archaeometric studies provide the scientific basis for the resolution of most of the questions that arose from the initial research by Thomas Lee.

This book is intended for the scholars and students of archaeology, including both geoarchaeology and Paleoindian studies, but also of Great Lakes paleoecology. Several differing perspectives are presented on the upper Great Lakes basin water level history; including both the gradually declining Lake Algonquin model, and the catastrophic discharge model, which indicates a major flood event into the upper Great Lakes from Lake Agassiz at ca. 9600 B.P. This book should also be of interest to avocational archaeologists and those interested in the history of archaeology in Ontario.

As a case study in Paleoindian artifact context and sediment analysis, and other aspects of geoarchaeology and archaeometry, such as Sheguiandah quartzite sourcing, this book should find merit with students learning new methods of analysis.

The editor wishes to thank all of those who contributed to this work, both in the 1950's and with the more recent re-investigations. Each of the chapter authors have also acknowledged those who assisted in their particular area. However, of special note is the work of Karen Vince, who assisted greatly in the compilation of this publication, and the assistance and patience of Richard Morlan. The editor would like to thank the First Nations of Sheguiandah and Sucker Creek, without whose co-operation in the Master Plan, this re-investigation may not yet have been completed.

Finally, this book and aspects of the research were funded in part by Laurentian University research grants to the editor from INORD (Institute of Northern Research and Development), the Ontario Heritage Foundation, Social Sciences and Humanities Research Council of Canada, and the Archaeological Master Plan, and all these sources are gratefully acknowledged.

Avant-Propos

Sheguiandah, dans la région supérieure des Grands Lacs, abrite un site paléoindien et archaïque stratifié rare. Il recèle des artefacts anciens enfouis dans des sédiments mixtes qui, de l'avis du premier chercheur et découvreur du site, Thomas E. Lee, constituent du till. Le rapport final sur les recherches archéologiques et géologiques effectuées dans les années 50 n'a jamais été achevé. Ce livre recense les renseignements disponibles sur le site, y compris le fruit des nouvelles recherches menées de 1989 à 1991, et fait état de l'étude subséquente sur l'histoire géologique et paléoenvironnementale de l'endroit. Il résout en outre la controverse de longue date touchant d'une part les artefacts contenus dans des sédiments mixtes de type till qui se trouvent au-dessous des pointes paléoindiennes et d'autre part, l'âge du site.

Le caractère unique et la valeur de ce rare site ancien stratifié n'ont pas chappé à Thomas E. Lee qui a réussi à convaincre le gouvernement de l'Ontario de le protéger. Cependant, il n'a pu terminer les études ni produire un rapport complet. À l'arrêt des travaux en 1955, le site a été laissé à l'abandon, faisant perdurer l'énigme et la controverse jusqu'à la reprise des activités en 1990.

Des collections d'artefacts se trouvent au Musée canadien des civilisations, au Musée royal de l'Ontario, au musée du canton de Howland, à Sheguiandah, dans plusieurs autres organismes et chez des particuliers. Il n'existe pas de catalogue exhaustif, seulement des numéros d'identification sur le terrain pour les grandes collections.

En 1989, le directeur de la publication a décidé d'analyser les collections, y compris les échantillons de sédiments, et de dater le charbon de bois et d'autres échantillons organiques excavés par Thomas E. Lee. La Fondation du patrimoine ontarien a subventionné la datation au carbone 14 par SMA, mais les résultats n'ont pas été concluants, car le charbon de bois et d'autres échantillons organiques étaient en mauvais état et le contexte incertain.

En 1990, en collaboration avec Bill Mahaney du laboratoire de géomorphologie et de pédologie de l'Université York, le directeur de la publication a analysé les échantillons de sédiments recueillis par Thomas Lee et Bruce Liberty dans les années 50 dans la zone d'habitation de Sheguiandah. Les résultats ont montré qu'une partie des dépôts sédimentaires controversés de type till étaient des mélanges de sable, de limon et d'argile, mais que les couches inférieures étaient des dépôts sablonneux triés. Il aurait fallu effectuer de nouvelles recherches et comparer ces sédiments avec des tills d'autres sites et des dépôts mixtes lacustres pour déterminer avec certitude l'origine géomorphique des dépôts mixtes contenant des artefacts.

En 1990, pour obtenir de nouveaux échantillons à dater au carbone 14, nous avons décidé de prélever de nouvelles carottes dans les petits marécages (tourbières) situés au sommet de la zone de la carrière de Sheguiandah. Nous avons communiqué avec Peter Storck, car il avait manifesté de l'intérêt pour reprendre les recherches, puis, avec Thane Anderson de la Commission géologique du Canada. Nous avons extrait des carottes et Thane a effectué l'analyse du pollen.

In 1991, une initiative de la municipalité du canton de Howland et des Premières Nations de Sheguiandah et de Sucker Creek a entraîné l'élaboration d'un plan directeur archéologique visant à la fois à conserver le patrimoine et à exploiter le potentiel touristique. Dans le cadre des recherches prévues dans le plan directeur, de nouvelles excavations ont eu lieu à Sheguiandah sous la direction des Archeological Services Inc. (ASI), une société torontoise de gestion des ressources culturelles.

Ron Williamson, président-directeur général d'ASI, a saisi le directeur de la publication de la possibilité de diriger les aspects archéologiques des nouvelles recherches. Il s'agissait en outre d'essayer de déterminer l'âge et l'origine des dépôts mixtes et la géochronologie du site. Nous avons alors pris contact avec Peter Storck, car il participait déjà avec nous à la collecte des carottes dans le marécage de Sheguiandah; d'autres spécialistes se sont joints à l'équipe, notamment les géologues Peter Barnett et Peter von Bitter.

Le directeur de la publication a aussi communiqué avec Robert E. Lee, le fils de Thomas E. Lee, pour l'inviter à participer aux fouilles effectuées dans les anciennes tranchées afin de prélever de nouveaux échantillons et de refaire des analyses. Robert a aussi fourni les cartes de son défunt père qui ont permis de situer certains sites d'excavation et sondages, ainsi que d'autres renseignements précieux. Plus tard, le directeur de la publication lui a demandé d'écrire l'historique des études de son père à Sheguiandah et de fournir des renseignements inédits (chapitre 2).

Les auteurs de chaque chapitre ont traité et évalué le site de Sheguiandah dans la perspective de leur propre discipline. Chaque chapitre est indépendant mais le directeur de la publication tente de faire le lien entre eux dans l'introduction et dans la conclusion; il offre aussi une perspective géoarchéologique sur la paléoécologie humaine de la fin du Pléistocène/début de l'Holocène concernant le site de Sheguiandah au sein de la région supérieure des Grands Lacs.

L'analyse des collections d'artefacts de Sheguiandah n'est pas terminée et exigera d'autres excavations et analyses. Étant donné que les responsables des premières excavations n'ont pas conservé tous les éclats d'artefacts et les nucléi, l'étude technologique de l'industrie lithique du quartzite de Sheguiandah fondée sur les collections actuelles est incomplète. Ces collections sont également très dispersées et les artefacts entreposés au Musée canadien des civilisations ne constituent pas nécessairement un échantillon représentatif.

Les principaux objectifs des nouvelles excavations de 1991 étaient de résoudre les questions géologiques sur l'âge et l'origine des dépôts mixtes controversés et de déterminer les limites du site par rapport à la zone désignée par T. Lee, sans toutefois rapporter de nouvelles collections archéologiques. Les objectifs et méthodes sont exposés en détail dans les chapitres 1 et 3 qui incluent également les points de vue des Premières Nations concernant les sites utilisés traditionnellement dans la région. Les recherches ont fourni un grand nombre de nouvelles données archéologiques sur Sheguiandah et ont permis de mieux comprendre les matériaux de diagnostic d'ordre culturel, comme les pointes, qui sont analysés par Peter Storck. Les études techniques d'ordre géologique, paléoenvironnemental et archéométrique fournissent la base scientifique utile pour résoudre la plupart des questions découlant de la recherche initiale menée par Thomas Lee.

Ce livre s'adresse aux savants et aux étudiants en archéologie, y compris en géoarchéologie et en études paléoindiennes, mais aussi en paléoécologie des Grands Lacs. Il présente des perspectives différentes sur l'histoire du niveau d'eau du bassin de la région supérieure des Grands Lacs, y compris sur le modèle de déclin graduel du lac Algonquin et sur le modèle de décharge catastrophique qui indique une inondation majeure de cette région provenant du lac Agassiz quelque 9 600 ans avant aujourd'hui. Ce livre devrait aussi satisfaire la curiosité des archéologues amateurs et des personnes qui s'intéressent à l'histoire de l'archéologie en Ontario.

En tant qu'étude de cas du contexte des artefacts paléoindiens et d'analyse des sédiments et d'autres aspects géoarchéologiques, comme la source du quartzite de Sheguiandah, ce livre devrait être utile aux étudiants qui apprennent de nouvelles méthodes d'analyse.

Le directeur de la publication souhaite remercier toutes les personnes qui ont contribué aux travaux, tant dans les années 50 que lors des recherches récentes. Les auteurs de chapitres ont aussi remercié leurs collaborateurs. Il convient en outre de souligner la contribution de Karen Vince, qui a apporté une aide précieuse dans la compilation de cet ouvrage, ainsi que l'assistance et la patiencé de Richard Morlan. Le directeur de la publication désire également remercier les Premières Nations de Sheguiandah et de Sucker Creek qui ont coopéré à l'établissement du plan directeur et sans lesquelles cette étude n'aurait pu être menée à bonne fin.

Finalement, nous sommes reconnaissants à l'INORD (Institut nord-ontarien de recherche et de développement) de l'Université Laurentienne, à la Fondation du patrimoine ontarien, au Conseil de recherches en sciences humaines du Canada et au Plan directeur archéologique, qui ont alloué des subventions au directeur de la publication pour financer en partie ce livre et certains aspects de la recherche.

Table of Contents

Dedication ... iii
Contributors ... iv
Preface ... v
Avant Propos ... viii
List of Figures ... xii
List of Tables ... xv

Chapter ... Page

1. Introduction to the Sheguiandah Site: Regional context and research questions
Patrick J. Julig and Peter L. Storck ... 1

2. History of the Initial Investigations: 1951-57
Robert E. Lee ... 11

3. Sheguiandah in 1991: The Role of Heritage Planning in the Reinvestigation of the Site
David A. Robertson, Eva M. MacDonald and Ronald F. Williamson ... 67

4. Geoarchaeological Studies of the Sheguiandah Site and Analysis of Museum Collections
Patrick J. Julig and William C. Mahaney ... 101

5. Projectile Points from the Sheguiandah Site
Peter L. Storck ... 139

6. Quaternary Geology, Stratigraphy and Sedimentology of the Sheguiandah Site
Peter J. Barnett ... 155

7. Pollen Stratigraphy and Vegetation History, Sheguiandah Archaeological Site
T.W. Anderson ... 179

8. Upper Great Lakes Climate and Water-Level Changes 11 to 7 ka: Effect on the Sheguiandah Archaeological Site
T.W. Anderson and C.F.M. Lewis ... 195

9. The Geological History of an Important Paleoindian Manufacturing Site: Sheguiandah, Manitoulin Island
Peter H. von Bitter ... 235

10. Characterization of Sheguiandah quartzite and other potential sources of quartzarenite artifacts in the Great Lakes region
D.F.G. Long, P.J. Julig and R.G.V Hancock ... 265

11. Archaeological Conclusions from the Sheguiandah Site Research
Patrick J. Julig ... 297

List of Figures

Figure Page
1.1 Map of selected Paleoindian sites along the north shore 2
1.2 Aerial photo of the Sheguiandah site 3
1.3 Topographic map of the Sheguiandah site 4
2.1 Photograph of the Sheguiandah site hill 13
2.2 T. Lee's contour map of the Sheguiandah site 14
2.3 T. Lee recording artifact positions 16
2.4 Kaye Price and Ken Dawson examining artifacts 17
2.5 T. Lee and his crew with surface finds 17
2.6 Old quarry pit beneath excavations 24
2.7 Thomas Lee and Fritz Knechtel 26
2.8 Crew at work in Station 7-1 27
2.9 Clyde Kennedy, Walter Kenyon, Jim Wright, and Bill Taylor 35
2.10 Lee's stratigraphic profile of Station 7-8 37
2.11 Walter Kenyon cleaning the bedrock floor of Swamp 1 38
2.12 Profiles of test pits in Swamps 1-4 41
2.13 Contour diagrams of fabrics 49
2.14 Profile of trench dug across Mystic Ridge 50
2.15 Lee's contour map of the Habitation Area 52
2.16 Profile of the Blasted Cave site 53
2.17 Gathering of Manitoulin Ojibways in 1953 62
3.1 The archaeological master plan study area 68
3.2 Map of 1953 site designation and 1990-1991 assessment and survey 73
3.3 Recommended redesignation of the Sheguiandah site 75
3.4 Selected artifacts from the south pasture 76
3.5 Selected artifacts from the south pasture 76
3.6 Archaeological sites within the vicinity of the Sheguiandah quarry 80
3.7 The Gravel Pit site 83
3.8 The Green Bay sites 85
3.9 Bifaces from the Valley 2 and Valley 3 sites 86
3.10 Generalized locations of traditional use sites 94
3.11 A modern sweat lodge erected on the Sheguiandah site 95
4.1 Map of the Sheguiandah archaeological site 104
4.2 Topographic profile of the Sheguiandah archaeological site 104
4.3 Cumulative grain-size curves of Habitation Area sediment samples 105
4.4 Cumulative grain-size curves of Station 7-8 sediment samples 107
4.5 Cumulative grain-size curves for sediment samples from the Mid-Quarry Ridge trench 108
4.6 Broken late stage biface preforms, refits 111
4.7 Late-stage bifaces and point preforms 112
4.8 Water polished bifaces 113
4.9 Large biface, refit, with broad facial flaking 113
4.10 Used biface fragments 114
4.11 Chert drills 115
4.12 Uniface end and side scrapers 115

Figure Page
4.13 Denticulate and notched unifaces 116
4.14 Microblade and macroblade-like flakes 117
4.15 Cumulative grain-size curves for samples SA10, SA20, SA30, SA40 121
4.16 Stratigraphic profile of Station 7-8, west wall, Habitation Area 123
4.17 Stratigraphic profile of Station 7-9, west wall, Habitation Area 124
4.18 Stratigraphic profile of Station 8-B, west wall, Habitation Area 125
4.19 Cumulative grain-size curves for sediment samples from unit 7-9W 127
4.20 Cumulative grain-size curves for sediment samples from unit 8-B 127
4.21 Stratigraphic profile of Mid-Quarry Ridge trench 130
4.22 Cumulative grain-size curves of the Mid-Quarry Ridge 130
4.23 Stratigraphic profile of Swamp 3 132
4.24 Stratigraphic profile of Swamp 4 133
5.1 Projectile point tips and mid-sections 144
5.2 Unstemmed and stemmed lanceolate points 145
5.3 Unstemmed lanceolate projectile point 145
5.4 Projectile point mid-section and unstemmed lanceolate points 146
5.5 Unstemmed and stemmed lanceolate projectile points 147
5.6 Unstemmed lanceolate projectile points 148
5.7 Notched and stemmed projectile points 150
5.8 Notched and stemmed projectile points 151
6.1 Matrix grain size distrubution of off-site till samples 159
6.2 Compact, fissile, sandy silt till exposed west of the Sheguiandah site 160
6.3 Present-day locations of post-glacial shorelines in the Sheguiandah area 161
6.4a Matrix grain size distribution of bay-mouth bar sediments 162
6.4b Matrix grain size distribution of lagoon bar sediments 163
6.5 Sheguiandah site location map 166
6.6 Stratigraphic profile of Station 7-8, west wall, Habitation Area 168
6.7 Stratigraphic profile of Station 7-9, west wall, Habitation Area 168
6.8 Stratigraphic profile of Station 8-B, west wall, Habitation Area 169
6.9 Matrix grain size distribution of on site diamicton and off site till 170
6.10 Matrix grain size distribution of debris flow and stratified sediment 171
6.11 Boulder layer at base of trench at Station 7-8 and 7-9 172
6.12 Matrix grain size distribution of Lee's two "till" units 173
6.13 Materials exposed on west wall of trench, Station 7-8 174
6.14 Boulder lag formed in the near-shore zone of glacial Lake Algonquin 176
7.1 Map of the Sheguiandah archaeological site 181
7.2 Modified pollen diagram of Terasmae, Swamp 3 184
7.3a New pollen diagram for Swamp 3 showing tree and shrub pollen percentages 185
7.3b New pollen diagram for Swamp 3 showing herb and aquatic pollen percentages 186
8.1 Map showing five north-south traverses across the Great Lakes 198
8.2a *Picea, Pinus,* and *Quercus* pollen successions from selected sites 202
8.2b *Picea, Pinus,* and *Quercus* pollen successions from selected sites 203
8.3 Lake surface variations in the Georgian Bay and Huron basins 205
8.4 The Hough-Stanley model of lake-level change in the Huron basin 211
8.5 Abbreviated pollen diagrams from the Pyle site, Indiana, and Bucyrus Bog, Ohio 217

Figure Page

8.6 Time-distance diagram showing the spruce front in the Great Lakes region 219
8.7 Approximate isochrone positions of the spruce-pine ecotone 220
8.8 Models of air mass circulation over the upper Great Lakes 223
8.9 Summary diagram showing climate and lake-level history 224
9.1 Quartzite knoll on which Sheguiandah Paleoindian site is located 237
9.2 Distribution of main rock types at the Sheguiandah Paleoindian site 238
9.3 Schematic geological cross-section of the quartzite knoll 239
9.4 Schematic cross-sections of depositional setting, deformation and metamorphism........239
9.5 Bar River Formation quartzite 241
9.6 Schematic sketch of angular unconformity..242
9.7 Angular unconformity between Bar River Formation and Lindsay Formation...............243
9.8 Stratigraphic column of geological units at Sheguiandah...244
9.9 Schematic cross-section between Sheguiandah and La Cloche Island...........................245
9.10 Schematic reconstruction of Late Ordovician sea 245
9.11 Conglomerate and breccia of the lower Lindsay Formation...247
9.12 Percussion marks on quartzite boulder of the Lindsay Formation 248
9.13 Fossil nautiloids and corals from the lower Lindsay Formation.....................................249
9.14 Bedrock sequence and reconstructed *Solenopora-Paratetradium* community...............250
9.15 Shale of the Lindsay Formation and fossils found therein 251
9.16 Blue Mountain Formation and reconstructed *Sowerbyella-Onniella* community 252
9.17 Glacial ice of the Wisconsin advance covering the Great Lakes region..........................253
9.18 Shoreline bluff and bar features formed as glacial Lake Algonquin was lowered 254
9.19 Cleavage in Bar River Formation quartzite 256
9.20 Rock samples from quartzite knoll on which Sheguiandah Paleoindian site is located ..257
9.21 Thin-sections cut from rock samples of Figure 9.20 258
9.22 Ordovician phosphatic microfossils (conodonts)..259
10.1 Quartzarenites in the upper Great Lakes region 267
10.2 Exposures of the Bar River Formation at archaeological sites 269
10.3 Polarized thin sections and CL features...275
10.4 Ternary plots of quartz grains in geological samples 278
10.5 Ternary plots of monocrystalline, polycrystalline and strained quartz grains 279
10.6 Canonical scatter-plot based on discriminant analysis of INAA data 286
11.1 Early and Late Paleoindian site, paleontological sites, and modern shorelines...............304
11.2 Water levels, glacial margins and vegetation provinces, 11,000-10,500 BP...................306
11.3 Water levels, glacial margins and vegetation provinces, 9500-9000 BP.........................307

List of Tables

Table Page

3.1 Archaeological Sites discovered by Lee's 1951 Survey 81
3.2 Summary of the traditional use site inventory 92
4.1 Grain-size data, Sheguiandah site, T. Lee's samples 106
4.2 Comparison of Sheguiandah Habitation Area biface samples 110
4.3 Sheguiandah site conjoined artifacts 119
4.4 Radiocarbon dates and sediment context from Swamps 3 and 4 121
4.5 Particle size data and Phosphorous 128
4.6 Clay mineralogy 129
5.1 Catalogue/reference numbers and provenience of projectile points 142
6.1 Description and interpretation of materials observed in trenches 167
7.1 AMS radiocarbon dates from Swamp 3 183
9.1 Geological history of Sheguiandah 240
10.1 Petrographic analysis of quartzites from the Great Lakes region 276
10.2 Major elements of geological quartzite determined by XRF analysis 282
10.3 Trace elements determined by XRF analysis of geological quartzite samples 284
10.4 INNA analysis of sandstones and artifacts 288

Chapter 1

Introduction to the Sheguiandah Site: Regional Context and Research Questions

Patrick J. Julig and Peter L. Storck

Abstract

Sheguiandah is a rare type of early archaeological site because it contains stratified Paleoindian and Archaic artifact assemblages, as well as alleged earlier cultural materials at the base of the site in mixed, "till-like" deposits. Discovered and excavated by Thomas E. Lee in the 1950s, the work was never completed and, lacking a final report, the site remained enigmatic and controversial. A reinvestigation of the artifact material held at the Canadian Museum of Civilization was initiated in 1989 by the first author. In 1991, a community initiative by a municipality and First Nations provided impetus for the development of an archaeological Master Plan for both conserving heritage resources and developing their tourism potential. As part of the Master Plan research, renewed excavations were conducted at Sheguiandah under the overall direction of a CRM firm in Toronto. Questions about the age and origin of the artifact-bearing mixed deposits underlying the Paleoindian levels helped to structure an interdisciplinary team and focus the research to address both site-specific questions and provide information about the environmental context for Paleoindian and later occupations in the upper Great Lakes.

Résumé

Sheguiandah est un type rare de site archéologique ancien parce qu'il contient, à sa base, sous forme de dépôts mélangés ressemblant à du till, des assemblages d'artefacts stratifiés paléoindiens et archaïques et des matériaux culturels que l'on suppose anciens. Découvert et excavé par Thomas E. Lee dans les années 1950, le site n'a jamais été complètement exploré et, faute de rapport final, il est demeuré énigmatique et controversé. Le premier auteur du présent ouvrage a entrepris une nouvelle étude des artefacts au Musée canadien des civilisations en 1989. En 1991, une initiative communautaire d'une municipalité et des Premières Nations a incité à établir un plan directeur archéologique touchant à la fois la conservation du patrimoine et l'exploitation de son potentiel touristique. De nouvelles excavations ont eu lieu à Sheguiandah, sous la direction générale d'une société de gestion des ressources culturelles de Toronto, dans le cadre des recherches préalables à l'élaboration du plan directeur. Des questions sur l'âge et l'origine des dépôts mélangés porteurs d'artefacts se trouvant sous les couches paléoindiennes ont servi de base pour structurer une équipe interdisciplinaire, mais aussi pour focaliser la recherche afin de trouver une réponse à des questions particulières au site et fournir des renseignements sur le contexte environnemental de l'occupation paléoindienne et des occupations ultérieures dans la partie supérieure des Grands Lacs.

The Sheguiandah Site: archaeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario, edited by P. Julig, Canadian Museum of Civilization, Archaeological Survey of Canada, Mercury Series Paper 161, 2002.

Overview of Sheguiandah Site History and Initial Investigations

It has now been nearly a half-century since Thomas E. Lee directed the National Museum of Canada excavations at the Sheguiandah site (BlHl-2), within the village after which the site was named, on north-eastern Manitoulin Island (Figures 1.1, 1.2, 1.3).

The first historical report of quartzite artifacts from Sheguiandah, including lanceolate type bifaces, is by J. Notman, who in 1877 gave specimens to geologist Robert Bell. Robert Bell (1878) also received artifacts in 1878 and 1881 from A.S. Cochrane, a resident of the village of Sheguiandah; these are in the Canadian Museum of Civilization collections (CMCC catalogue, Accession # 1482). Unfortunately, there is no precise record of the locations of these finds.

In 1951 Thomas Lee and his field assistant Doug Bell discovered quartzite artifacts in a field on the outskirts of Sheguiandah village, south of Little Current. They found that the site was large, and covered the top of a quartzite knoll of about 10 hectares, east of Highway 6 (Figure 1.3). In his 1953 report, Thomas Lee described a large site of "almost unbelievable magnitude and richness" with many white quartzite blades and bifaces lying around the surface, with little soil accumulation on the rocky hill; he believed the site had been little disturbed since prehistoric times.

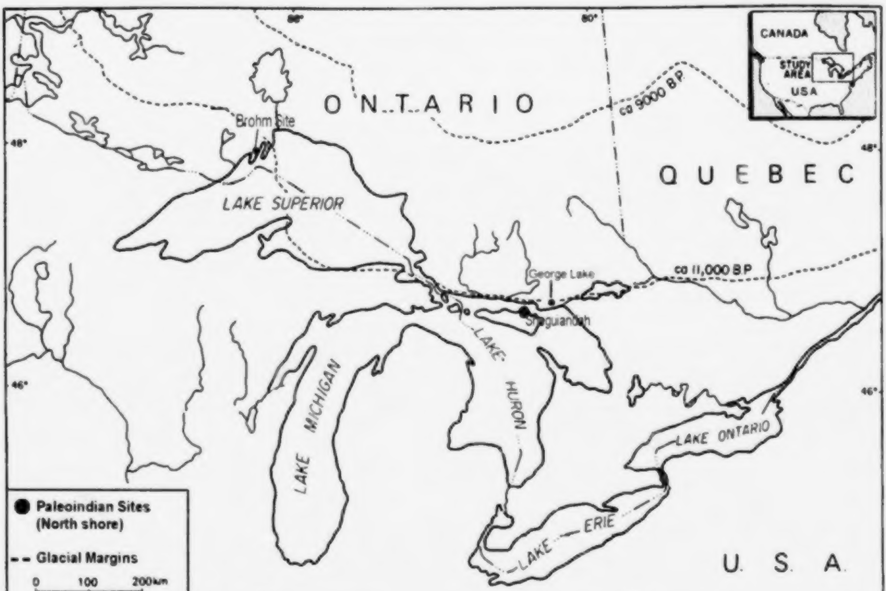

88°
80°
CANADA
STUDY AREA
USA
ONTARIO
co 9000 B.P.
Brohm Site
48°
48°
QUEBEC
LAKE SUPERIOR
George Lake
co 11,000 B.P.
Sheguiandah
LAKE
HURON
LAKE MICHIGAN
46°
46°
LAKE ONTARIO
LAKE ERIE
U. S. A.
Paleoindian Sites (North shore)
Glacial Margins
0 100 200km
88°
80°

Figure 1.1. Selected Paleoindian sites along the North shore reported in the 1950s, and approximate glacial margins.

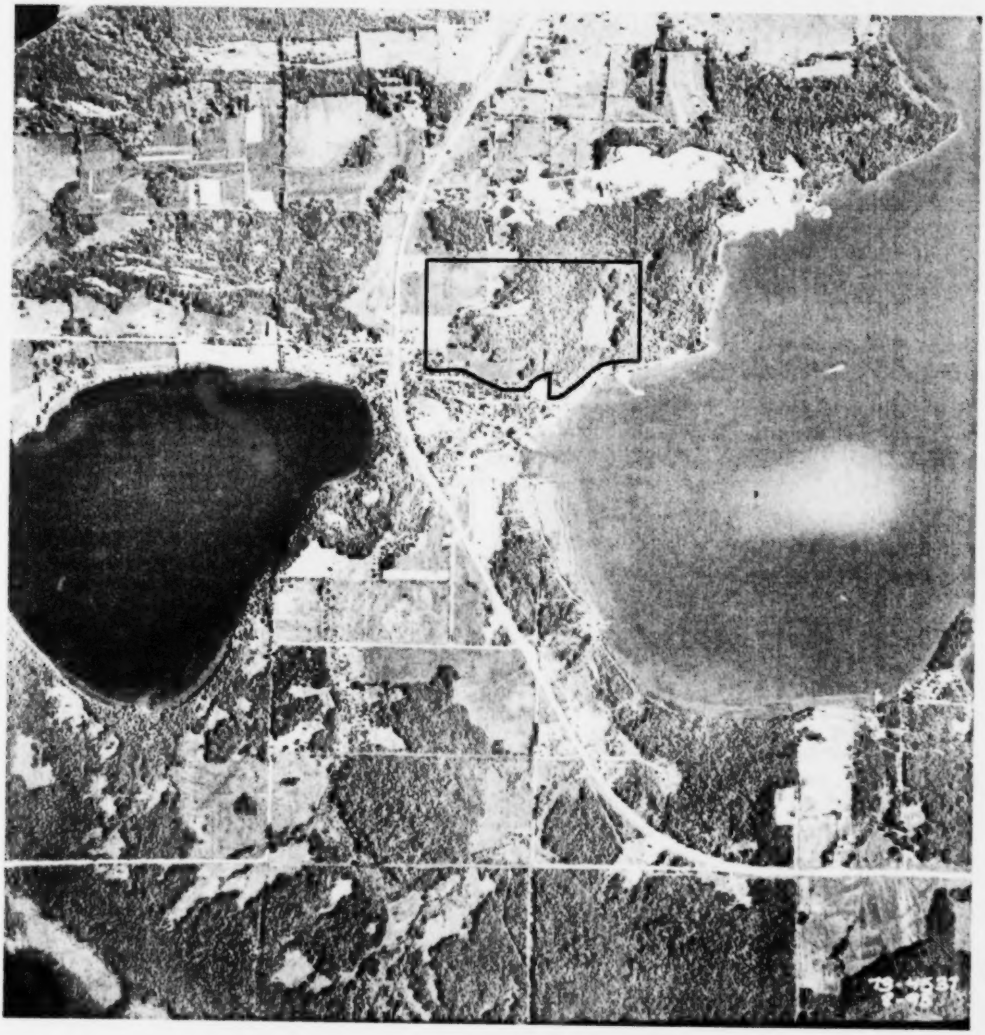


Figure 1.2. Aerial photo of the Sheguiandah site (designated area outlined in black), and the surrounding area. North is to the top, with the village of Sheguiandah in the center of the photograph, between Bass Lake (left) and Sheguiandah Bay (right).

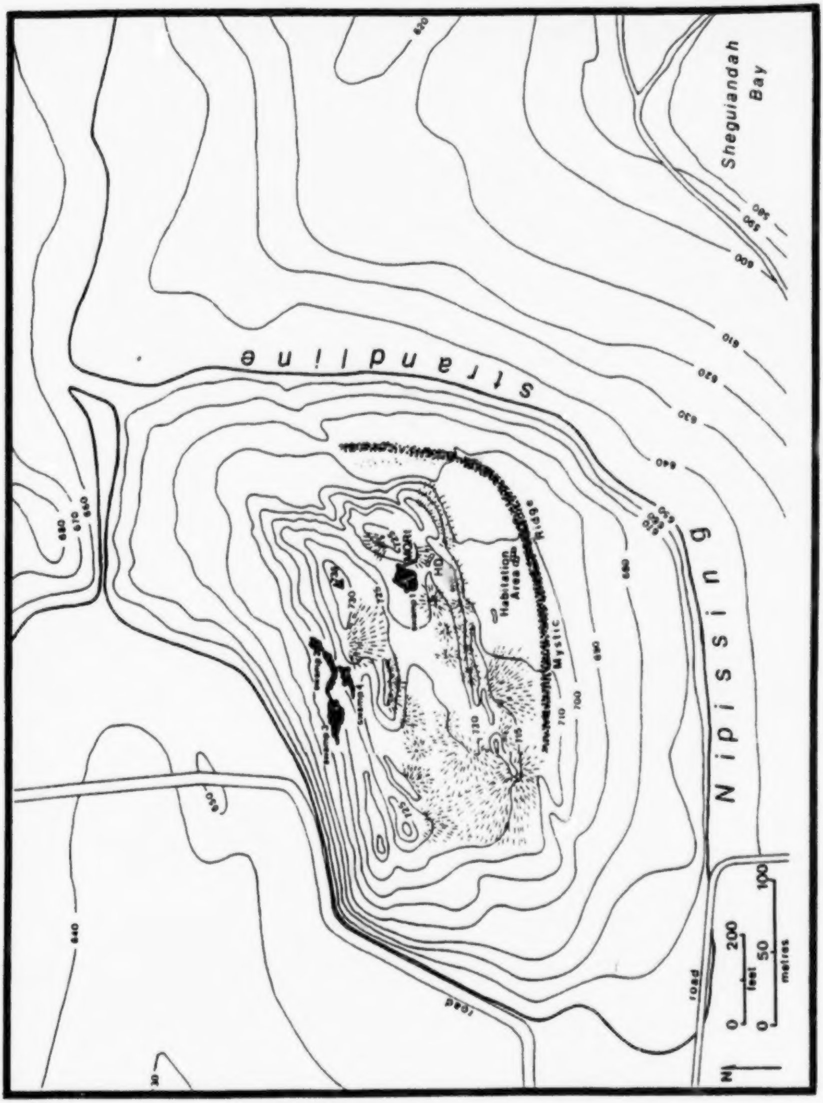

Sheguiandah Bay
Strandline
Nipissing
Habitation Area
Mystic Ridge
road
road
580
590
600
610
620
630
640
660
670
680
690
700
710
715
720
725
730
0 200 feet
0 50 100 metres
N

Figure 1.3. Topographic map of the Sheguiandah site knoll, indicating Nipissing beach and the Habitation Area above the Mystic Ridge (from T. Lee, 1957a).

Lee commenced major field work on this complex site in 1952 with volunteer help from the then fledgling OAS (Ontario Archaeological Society), with William Taylor as foreman (R. Lee, this volume). Work in the "Habitation area" was commenced by laying out 10 foot squares around a quartzite outcrop, where the soil was not too thick, numbering the squares ("stations") as they were opened (Figure 1.3). There was no formal grid system, but these "stations" can still be located today, as they were outlined by Lee with boulders when he left the site. After the first year, Lee (1954) reported "no clear-cut stratigraphy", other than an upper-humus and a "transitional" powdery soil (podzolic horizon) from which they recovered Paleoindian points. These were underlain by mixed deposits with artifacts, later tentatively identified by John Sanford, geologist of Wayne State University, as glacial till (Lee 1953, 1954, 1955, 1956, 1957a, Sanford 1957). In the first year Lee also excavated the quarry "Hillside Dump" area, and made extensive surface collections. Worked material was so abundant that Lee only saved clear artifacts and only samples of the cores and flakes. The artifacts were marked with the field designations, including station and depth; unfortunately this information was not pulled together into a formal site catalogue.

Thomas Lee was very concerned about the possibility of the site being looted, and managed to have the site protected by the Ontario Government under a new statute, The Archaeological and Historic Sites Protection Act (1953). This was a major accomplishment for the Sheguiandah site in particular and in archaeological heritage resources generally, ultimately leading to the Ontario Heritage Act (1980).

Lee's subsequent excavations at Sheguiandah from 1955 to 1957 are reviewed by his son, Robert E. Lee (this volume). There are many articles and reports by T. Lee on various aspects of the Sheguiandah site over the years (1953, 1955, 1956, 1957a, 1957b, 1963a, 1963b, 1964, 1968, 1974, 1979, 1983) but no final report.

There are other Paleoindian sites reported on and investigated in the upper Great Lakes North Shores during the 1950's, including Brohm (MacNeish 1952) and George Lake (Greenman and Stanley 1943) (Figure 1.1). There appears to have been some conflict and competition between T. Lee and E. Greenman at this time, affecting initial research on Manitoulin Island, and the Sheguiandah research in particular (R. Lee, this volume).

Lee's work at Sheguiandah produced a great deal of information about the archaeology and geology of the site. Although his field methods were by all accounts excellent, excavation was prematurely halted in 1956 due to funding problems and other complexities (see R. Lee, this volume). As a result the fieldwork at this site was not completed and because Lee was forced to leave this site prior to completion this lead to a long-term controversy. Tom Lee and his field geologist Sanford (1957) reported quartzite artifacts in and below two glacial "till" or diamicton deposits, and the date of ca. 30,000 was suggested by them as a minimum age. However because there was no final report or resolution, the site became clouded in controversy over whether it was a possible Pre-Clovis site. The possibility of artifacts in glacial deposits (till) remained unsolved.

Unfortunately, while the post-glacial water levels in the Huron Basin had been studied by Hough (1958) these water planes were not yet accurately dated or well related to the site at the time of the research by Lee and the geologist Sanford (1957). The Lee excavations were suspended at the end of the 1955 season, and although charcoal and other organic samples were taken, no additional radiocarbon dating was conducted to resolve the problems in site geochronology, beyond the single date reported in Lee (1957a).

For the next thirty years Sheguiandah was occasionally proposed as a possible Pre-Clovis age site (Lorenzo 1978) with ongoing discussions by Robert Lee (1986), who restated many of the positions of his father. Karrow (1987), commented on the key geological and geochronological issues and called for re-investigation.

In 1975, Storck attempted to re-new investigations at Sheguiandah but was refused a license for test excavations by the Ontario Heritage Foundation which, to economize the site's resources, wanted to see larger scale excavations.

During the early 1980's Julig visited the site for photographic purposes, accompanied by the late Clyde Kennedy, who had worked on of Lee's crews. Julig had originally planned to study the Sheguiandah site as doctoral research at the University of Toronto, but instead chose the Cummins Site (Julig 1988), as it was less controversial. He planned to re-investigate the Sheguiandah site subsequently, when the research at Cummins was completed.

In 1985, Julig (1985) proposed three hypothesis for the occurrence of the artifacts in the Sheguiandah "Habitation Area" mixed Level III and IV deposits: 1) active beach and ice-plowing activities during fluctuating water levels in post-Lake Algonquin times, 2) down slope colluvial activities (as the "Habitation area is at the base of a slope), and 3) renewed glaciation at ca. 10,000 years B.P. (during the Marquette advance). The first hypothesis was favoured based on the observation of similar archaeological-geological facies being recorded in lower pro-glacial Lake Minong beach deposits in the Cummins site, Thunder Bay (Julig 1984, 1990; Julig *et al.* 1990).

In 1989 and 1990, Julig and W.C. Mahaney conducted research and analysed some of the existing Sheguiandah collections excavated by T. Lee (Julig et al. 1994). Objectives of this research were to: 1) examine selected artifacts from various levels in the site, particularly controversial Levels III and IV in the so-called "till" units, for evidence of differences in lithic technology that might support the cultural stratigraphy as interpreted by Lee; 2) examine characteristics of the sediments to determine their possible origin and environments of deposition; 3) tabulate the number and locational context of portions of conjoined artifacts to determine the extent of post-depositional mixing in the sediments; and, 4) obtain charcoal or other organic material for AMS radiocarbon dating.

The preliminary results of these studies were reported in Julig *et al.* 1994, and will be reviewed in a later chapter (Julig and Mahaney, this volume). These studies were planned so as to learn as much as possible about Sheguiandah and about how to resolve the outstanding research questions, prior to starting re-investigations.

Renewed field investigations at Sheguiandah began later in 1990 when Julig, P. Storck and T. W. Anderson (GSC) conducted coring activities of Swamp 3, to obtain samples for pollen analysis and additional C-14 dating (Storck *et al.*1991, Julig *et al.*1991, 1994), for which funding had been obtained. The pollen results and additional dates are in Anderson (this volume).

As the analyses of existing collections and dating of new cores were in progress, a local initiative arose in the context of an archaeological Master Plan study, which was initiated by Howland Township, Sheguiandah First Nation, and the Ojibways of Sucker Creek, with the work being carried out by Archaeological Services Inc. of Toronto (see Robertson *et al.* this volume). The mandate of this Master Plan included a regional survey of Howland Township, re-surveying the Sheguiandah site (BlHl-2) to determine more precisely the extent of site boundaries, and to try and resolve the issues of the site geochronology and analysis of the controversial mixed deposits (till?) with artifacts by re-excavating the old pits and trenches of T. Lee from the 1950s. This information was needed in order to address planning issues related to cultural heritage and tourism ventures. Ron Williamson and Martin Cooper contacted P. Julig to assist on the geoarchaeological aspects of the Sheguiandah Site investigations. This opportunity changed the academic / archaeology plans of the senior author, as it was important to assist in this CRM based research. P Storck was also asked to become involved, at the request of P. Julig, as he had expressed a long-term interest in the site (Julig and Storck, 1992).

Review of Key Research Questions and Objectives

Because of the long-term controversy over the alleged earlier deposits at Sheguiandah, the site has been considered enigmatic. Some have described it as "Canada's most neglected major site of the past 30 years" (Jackson and McKillop 1987). We briefly review the geoarchaeological strategy of the most recent research toward resolution of site geochronology, stratigraphic context of the controversial lower deposits, site formation issues, and palaeoenvironmental context.

Geological and paleoenvironmental studies are often conducted in conjunction with archaeological research. In most instances, these studies provide additional data that augment and enrich the archaeological interpretations. However, for some archaeological projects, these studies are much more fundamental; indeed mandatory, for archaeological interpretation (for example see Stein and Farrand 1985; Julig *et al.*1990).

Two approaches were used in re-opening investigations at the Sheguiandah site. These involved:1) an analysis (or re-analysis) of selected artifacts and soil/sediment samples obtained by Lee, as well as 2) limited re-excavations and re-sampling of selected squares/trenches opened by Lee during field work in the early 1950's, and comparison to off-site tills and other deposits. In addition, geological, palynologyical and quartzite sourcing studies are used to augment the archaeological interpretation. Results of these research activities are discussed in the following chapters.

This book is not meant as a complete and final resolution of all the archaeological issues and questions about Sheguiandah, but rather a report on the major findings from the 1991 CRM investigations (Robertson *et al.* this volume) and related multidisciplinary investigations; within the context of current knowledge of Paleoindian studies in the upper Great Lakes. R. Lee has provided a detailed historical perspective on the initial investigations from his father's papers and family archives. The analyses of the Lee sediment and artifact samples provided the context to organize the re-investigations, including the critical off-site comparisons (Barnett, this volume). These multi-faceted re-investigations resolve most of the key issues about Sheguiandah site geochronology, geoarchaeological context and paleoenvironment (Anderson, and Anderson and Lewis, this volume). Related archaeometric methods, such as the sourcing of quartzite artifacts (Long *et al.* this volume), indicate the possibility of exploring Sheguiandah connections to other sites.

Sheguiandah is a rare stratified site, stratified not only vertically, but in the horizontal sense, like some of the famous arctic sites. The long-term multiple occupations and archaeological deposits stretch from the modern water level of Sheguiandah Bay to the top of the hill (Figure 1.3), with Middle Woodland at the Algoma water level, Archaic below the Nipissing beach level, and Paleoindian and later occupations stratified (and mixed) at the Korah level in the "Habitation Area" (Barnett, Anderson and Lewis, and Julig and Mahaney, this volume). The following chapters will deal with the description and analysis of the site geology, archaeology, and paleoenvironment, and the context from which this information was recovered.

References

Bell, R. 1878. Report on geological researches north of Lake Superior and east of Lake Superior. *Geology of Canada: Report of Progress for 1876-77*. Ottawa: Geological Survey of Canada, pp.193-220.

Hough, J.L. 1955. Lake Chippewa, a low stage of Lake Michigan indicated by bottom sediments. *Geological Society of America Bulletin*, 66: 957-968.

Hough, J.L. 1958. *Geology of the Great Lakes*. Urbana, Illinois: University of Illinois Press.

Greenman, E.F. and G.M. Stanley. 1943. The archaeology and geology of two early Sites near Killarney, Ontario. *Papers of the Michigan Academy of Science, Arts and Letters*, Vol. 28: 505-531.

Jackson, L.J. and H. McKillop.1987. Patterns in prehistory: the Sheguiandah Site, 1952-1956. *Arch Notes: Newsletter of the Ontario Archaeological Society* 87(1): 9-15.

Julig, P.J. 1984. The Cummins Paleo-Indian site and it's paleoenvironment, Thunder Bay, Canada. *In* New Experiments on the Record of Eastern Paleo-Indian Cultures, M. Gramly, ed. *Archaeology of Eastern North America* 12: 192-209.

Julig, P.J. 1985. The Sheguiandah site stratigraphy: a perspective from the Lake Superior Basin. *Ottawa Archaeologist* 12(8): 3-13.

Julig, P.J. 1988. *The Cummins site complex and Paleoindian occupations in the northwestern Lake Superior Region*. Doctoral dissertation, Department of Anthropology, University of Toronto.

Julig, P.J. 1990. The effect of Lake Agassiz flood events on northern Great Lakes Paleo-Indian sites: examples from the Superior and Huron Basins. Paper presented at joint meetings of Canadian Quaternary Association and American Quaternary Association, University of Waterloo, June 1991.

Julig, P.J., J.H. McAndrews and W.C. Mahaney. 1990. Geoarchaeology of the Cummins Site on the beach of proglacial Lake Minong, Lake Superior basin, Canada. In *Archaeological Geology of North America,* N.P. Lasca and J. Donahue, eds. Boulder, Colorado: Geological Society of America, Centennial Special Paper 4: 21-50.

Julig, P.J., W.C. Mahaney and P.L. Storck. 1991. Preliminary geoarchaeological studies of the Sheguiandah site, Manitoulin Island, Canada. *Current Research in the Pleistocene* 8: 110-112.

Julig, P.J. and P.L. Storck. 1992. Survey and re-excavation of the Sheguiandah Site. *In* Archaeological Services Inc.: report on Phases 1 and 2 of the Archaeological Master Plan for the Township of Howland, Ojibways of Sucker Creek and the Sheguiandah First Nation, pp.30-89. MS on file with the Ontario Ministry of Citizenship, Culture and Recreation, Toronto. Archaeological Research Grant ARG-512.

Julig, P.J., R.P. Beukens and W.C. Mahaney. 1994. Geochronology of the Sheguiandah Site (BlHl-2), Manitoulin Island, Ontario. Report to the Ontario Heritage Foundation.

Julig, P.J., P.L. Storck and W.C. Mahaney. 1994. Re-investigations at Sheguiandah: the application of a geoarchaeological approach. In *Great Lakes Archaeology and Paleoecology: Exploring Interdisciplinary Initiatives for the Nineties (symposium proceedings),* R.I. MacDonald, ed. Quaternary Sciences Institute, University of Waterloo, pp. 237-262.

Karrow, P.F. 1987. Comments on: "Geology of the Sheguiandah Early Man site: key concepts and issues" by R.E. Lee. *Géographie Physique et Quaternaire* 41: 403-405.

Lee, R.E. 1986. Geology of the Sheguiandah early man site: key concepts and issues; *Géographie Physique et Quaternaire* 40: 325-330.

Lee, T.E. 1953. A preliminary report on the Sheguiandah Site, Manitoulin Island. *National Museum of Canada Bulletin* 128: 58-67.

Lee, T.E. 1954. The First Sheguiandah Expedition, Manitoulin Island, Ontario. *American Antiquity* 20(2): 101-111.

Lee, T.E. 1955. The Second Sheguiandah Expedition, Manitoulin Island, Ontario. *American Antiquity* 21(1): 63-71.

Lee, T.E. 1956. Position and meaning of a radiocarbon sample from the Sheguiandah Site, Ontario. *American Antiquity* 22(1): 79.

Lee, T.E. 1957a. The antiquity of the Sheguiandah Site. *Canadian Field Naturalist* 71(3): 117-137.

Lee, T. E. 1957b. An archaeological survey of southwestern Ontario and Manitoulin Island. *Pennsylvania Archaeologist* 29(2): 80-92.

Lee, T.E. 1963a. A Point Peninsula Site, Manitoulin Island, Lake Huron. *Bulletin of the Massachusetts Archaeological Society* 26(2): 19-30.

Lee, T.E. 1963b. "Unpublished" Sheguiandah? Comments by the Editor. *Anthropological Journal of Canada* 1(4): 32.

Lee, T.E. 1964. Sheguiandah: Workshop or Habitation? *Anthropological Journal of Canada*, 2(3): 16-24.

Lee, T.E. 1968. The question of Indian origins, again. *Anthropological Journal of Canada*, 6(4): 22-32.

Lee, T.E. 1974. Sheguiandah Viewed in 1974. *NEARA Newsletter* 9(2): 34-37.

Lee, T.E. 1979. Sheguiandah and Early Man. *Geology of the Manitoulin Area*, Michigan Basin Geological Society Special Publication No. 3: 87-89.

Lee, T.E. 1983. Son of Deac, Native of Port Bruce. *Anthropological Journal of Canada* 21: 29-45.

Lorenzo, R.E. 1978. Early Man research in the American hemisphere: appraisal and perspectives. In *Early Man in America from a Circum-pacific perspective*, A.L. Bryan, ed., Occasional Papers No. 1, Department of Anthropology, University of Alberta, Edmonton, pp. 1-9.

MacNeish, R.S. 1952. A possible early site in the Thunder Bay District, Ontario. *National Museum of Canada Bulletin* 126: 23-47.

Sanford, J.T. 1957. Geologic observations at the Sheguiandah site. *The Canadian Field-Naturalist* 71: 138-148.

Sanford, J.T. 1971. Sheguiandah reviewed. *Anthropological Journal of Canada* 9(1): 2-15.

Stein, J.K. and Farrand, W.R. 1985. Context and geoarchaeology: an introduction. In *Archaeological Sediment in Context*, J.K. Stein and W.R. Farrand, eds., pp. 1-3. Center for the Study of Early Man, Institute for Quaternary Studies, University of Maine, Orono.

Storck, P.L., Julig, P.J. and Anderson, T.W. 1991. Pollen coring activities at the Sheguiandah site, Manitoulin Island. *Second Annual Archaeological Report, Ontario* (New Series) 2: 112-114

Chapter 2

History of the Initial Investigations: 1951-57

Robert E. Lee

Abstract

In the 1950s, Sheguiandah, on Manitoulin Island, Ontario, was one of those rare finds -- a major archaeological site discovered by a professional archaeologist in an undisturbed state. During four long field seasons with large crews, Thomas E. Lee of the National Museum of Canada defined it as a stratified site involving several distinct pre-ceramic cultures that had worked with the native quartzite. The youngest of these was associated with a high water stand called Great Lakes Nipissing, about 5000 years ago, when the hill that the site stands on was an island. Older cultural material, lacking projectile points, was in deposits with the attributes of glacial till in primary position. Evidence suggested that the artifacts had survived glaciation because of their position on the down-ice, or lee side of the hill. Archaeologically, the key to Lee's interpretations was a thin stratum lying between the younger and older materials, associated with projectile points of the Paleoindians, the first people who could have arrived in the area after the end of glaciation. Geologically, interest focused on the older artifact-bearing deposits. These were unsorted, and bore stones foreign to the site (a proportion of which were faceted and striated), as well as rounded sandy inclusions. Orientation studies revealed weak to moderately strong fabrics consistent with regional ice flow. In parallel work, four small swamps on the crest of the hill were drained and test-trenched. The bottom of the peat gave a ^{14}C date of 9,130 years, appropriate for the emergence of the site from the deep waters of glacial Lake Algonquin. Again, artifacts were found in inorganic sediments below this level. Because of the inferred age of the older artifacts in both parts of the site (more than 30,000 years), controversy attached itself to the site early on, both driving Lee's investigations, and blocking his determined efforts to publish. Many archaeological and geological figures of the time became involved. This chapter covers in detail the history of these many events, as well as some closely related issues, such as Sheguiandah's role in stimulating Ontario's first protective archaeological legislation.

Résumé

Dans les années 1950, Sheguiandah, sur l'Île Manitoulin (Ontario) faisait partie des rares trouvailles : un site archéologique majeur intact découvert par un archéologue professionnel. Pendant quatre longues saisons sur le terrain en compagnie de grandes équipes, Thomas E. Lee du Musée national du Canada, l'a défini comme un site stratifié comportant la trace de plusieurs cultures pré-céramiques distinctes qui avaient travaillé le quartzite local. La plus jeune des ces cultures était associée à un plan d'eaux hautes appelé Grands lacs Nipissing, âgé d'à peu près 5 000 ans, lorsque la colline sur laquelle se trouve le site était une île. D'autres matériaux culturels, auxquels manquaient les pointes de projectile, se trouvaient dans des dépôts avec les attributs du till en position primaire. Des preuves suggèrent que les artefacts aient réchappé à la glaciation grâce à leur position sur la face aval ou sur le flanc raide de la colline. Sur le plan archéologique, la clé des interprétations de Lee se trouvait dans une fine strate prise entre les

The Sheguiandah Site: archaeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario, edited by P. Julig. Canadian Museum of Civilization, Archaeological Survey of Canada, Mercury Series Paper 161, 2002.

matériaux anciens et plus récents, qui comportait des pointes de projectile des Paléoindiens, les premiers peuples qui auraient pu arriver dans la région après la glaciation. Sur le plan géologique, l'intérêt s'est surtout concentré sur les dépôts d'artefacts anciens. Ces objets n'étaient pas triés et comportaient des pierres étrangères au site (dont certaines avaient des facettes et des stries), ainsi que des inclusions sableuses arrondies. Des études d'orientation ont révélé des textures, allant de molles à modérément solides, conformes à l'écoulement de la glace régionale. Au cours de travaux parallèles, quatre petits marais au sommet de la colline ont été drainés et creusés de tranchées d'exploration. La datation au ^{14}C dans le fond de la tourbe a donné 9 130 ans, date appropriée pour l'émergence du site des eaux profondes du lac glaciaire Algonquin. Là encore, des artefacts ont été découverts dans des sédiments inorganiques sous ce niveau. En raison de l'âge présumé des artefacts anciens dans les deux parties du site (plus de 30 000 ans), la controverse qui est née dès le début a commandé les recherches de Lee mais a aussi bloqué ses efforts résolus à publier ses résultats. Beaucoup de grands noms de l'archéologie et de la géologie de l'époque se sont mis de la partie. Ce chapitre relate en détail l'histoire d'un grand nombre de ces événements ainsi que certains sujets étroitement liés, comme le fait que le cas de Sheguiandah s'est traduit par la première loi ontarienne de protection des sites archéologiques.

Introduction

> *Ground in the mills and shaped in the moulds of our great universities, I set out in 1950 to do my bit in filling some of the small gaps in knowledge of the American Indian which, fortunately, still remained. The picture was quite clear ... all Indians came to America fairly recently across Bering Strait. Folsom Man ... Clovis and Sandia. Wave upon wave of immigrants ... fanned out, ultimately, to the farthest reaches of the Americas, and moved northward into glaciated areas as the ice retreated.*
>
> *For me, this beautiful and naive picture crashed into irreparable ruin in 1951, with the discovery of the Sheguiandah Site on Manitoulin Island ... and the initial announcement of Geologist Dr. John Sanford of Wayne University that the lower levels of artifacts there were embedded in glacial till in primary position* -- T.E. Lee (1968).

The Sheguiandah Site was discovered by Thomas E. Lee and his field assistant Doug Bell in 1951, during the third year of a province-wide survey program for the National Museum of Canada (Lee 1953). Lee was on Manitoulin Island, looking particularly for some traces of an early and unusual culture that Emerson Greenman (Greenman and Stanley 1943) had found at Killarney, about 30 km to the east across Georgian Bay.

Greenman had long before gained approval for archaeological work in the Manitoulin District by promising the National Museum "all information in addition to actual material" (Letter to W.J. Wintemberg, 4th June 1938). Lee found that none had ever been forthcoming, and that now, as an officer of that Museum, his requests were condescendingly rebuffed (Lee 1983).

Indignant that a "foreign university party operating in my own country and territory" was witholding both the information and specimens that had been removed from Canada, he had set out "for the express purpose of breaking the monopoly of the University of Michigan on the oldest evidence of man in Canada" (Lee 1976b).

The discovery was made when Lee spotted pieces of quartzite in a cultivated garden on the outskirts of the small village of Sheguiandah, and investigated (Figure 2.1). The site, however, only just touched the garden; with growing excitement, it was found to cover most of a 10-hectare hill on the other side of the road. Lee was staggered: in his preliminary report he described it as "an amazing discovery ... an Indian site of almost unbelievable magnitude and richness. On the surface, among grass roots, leaves and moss ... were hundreds of large leaf-shaped blades and other artifacts!" (Lee 1953). The large, gleaming white quartzite bifaces were visible at a distance, "sometimes lying in the midst of little nests of fine chips or flakes, just where they had been made" (Lee 1953). Evidently there had been little soil accumulation over much of the rather rocky hill, and no significant disturbance since prehistoric times.

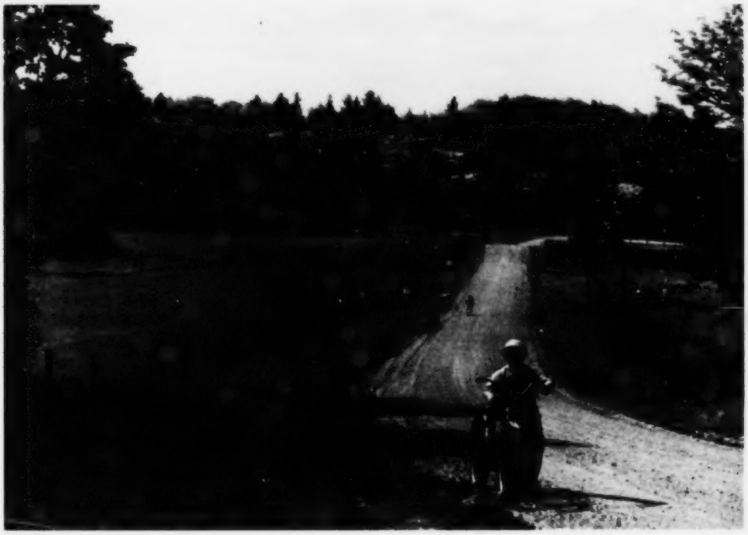


Figure 2.1. Battered by the thrust of the Wisconsin glaciers, the steep north face of the Sheguiandah Site hill, seen here, was too much shattered for later aboriginal stoneworking, and is almost devoid of cultural material. But just over the crest and down the slope beyond, high-quality quartzite was extensively quarried in prehistoric times. Lee's discovery was made farther along this same road, where it swings around the more gentle western reaches of the hill.

There were also quarried exposures of quartzite with accumulations of quarry debris at places over the hill. "Toward the top ... spreading out in a great fan below an Indian quarry and covering about one third of an acre, a solid paving of quartzite blocks, chips and worked fragments was revealed! Blades ranging from crude to fine specimens were found over the surface of the fan -- and there was no indication of how deep the mass of debris might go!" (Lee 1953). Complete bifaces and hammerstones lay on the quarry ledges, creating an eerie impression that the Indians had only just downed their tools and walked away.

An area of probable habitation was identified on the only sheltered, level spot on the hill (Figure 2.2). It was close to a source of drinking water and test pitting revealed quantities of fine chippings in the soil. Lee judged the site to be pre-ceramic and archaeologically early, though younger, of course, than its first exposure after the drainage of glacial Lake Algonquin. But the lowest occurrence of artifacts was still far above the present level of Lake Huron, suggesting that occupation took place during a higher stage of the lake. That, and the finding of two bifaces that showed considerable smoothing "such as is accomplished by wave action," opened the possibility of geologically dating the site (Lee 1953).

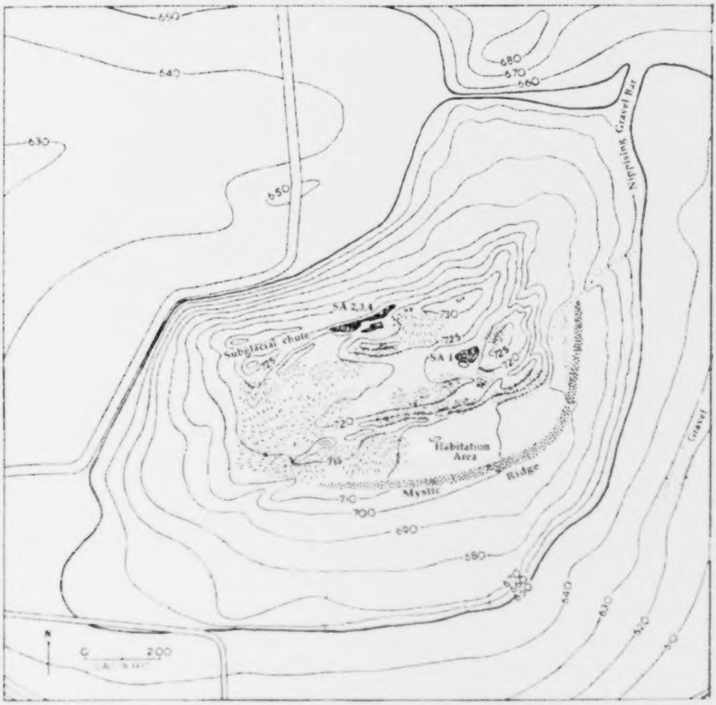

650
640
630
650
680
670
660
Nippising Gravel Bar
SA 2,3,4
730
Subglacial chute
725
725
SA 1
725
720
720
715
Habitation Area
Ridge
Mystic
710
700
690
680
670
660
650
640
630
620
610
Gravel
N
0 200
SCALE IN FEET

Figure 2.2. Lee's map shows the Great Lakes Nipissing notch that bounds the site at the 650-ft contour level (heavy line), and the fans of debris from prehistoric quarrying of that period. The Mystic Ridge encloses the Habitation Area, where artifacts were excavated from deposits thought to be glacial till. Swamp Areas 2, 3 and 4, which also produced artifacts, lie along the path of a short subglacial chute that coursed along the crest of the hill.

Lee named the site Sheguiandah after the modern village of that name, pronouncing all four syllables: "Sheg-wee-an-dah." That he had a sound basis for doing so is indicated by early spellings rendered by geologist and explorer Robert Bell: "She-gua-an-dah" (Bell 1866) and "Sheguaenda" (Bell 1878). Increasingly, however, the spoken word is being shortened to three softer syllables: "Sheg-win-da."

"Our triumph did not stop there," Lee later remembered. Pursuing the search for the quartzite-using culture, within days he and Bell had hit on the nearby Giant Site in a cultivated field (Lee 1954a). "Not even Sheguiandah could exceed the richness of this site," he said. "Enormous bifaces -- or blades, as we called them -- lay everywhere in the loose soil ... for a full half-mile .... It is fair to say that we felt like giants ourselves, after two such discoveries. Never was a monopoly so outrageously shattered as was that of the University of Michigan" (Lee 1976a).

But within the context of Lee's survey plan, it was the Sheguiandah Site that met his requirements for examination in depth. It represented an early and poorly known period in Ontario prehistory, and it was virtually undisturbed, offering unparalleled opportunity to the archaeologist. Lee made plans to excavate there the following year.

The First Sheguiandah Expedition: 1952

To learn as much as possible about such an extensive site in a single season, Lee proposed an expedition larger than any the National Museum had ever before mounted. Approval for his plans came so late in the spring, however, that scarcely any archaeology students remained available to work for the summer. Helpfully, Norman Emerson, of the University of Toronto, suggested he take on volunteers from the Archaeology Club, which was in the process of becoming the Ontario Archaeology Society (OAS). Thus began a mutually enriching association that lasted throughout the years Lee was employed at the National Museum (Roberts 2001).

Goals and Methods

In the last days of June, 1952, Lee and his foreman, William Taylor, Jr., raised a tent camp for 25 on the shore of Sheguiandah Bay. Lee's principal goals were to investigate the possibility of geological dating; determine whether the site involved only quarry workshops, or workshops and village; and to distinguish any stratification that might exist (Lee 1954b). To achieve these ends, the crew would have to dig with a refinement they were unlikely to have seen before.

As the crew assembled, Lee gave them orientation tours and began to teach them how he wanted things done. Even archaeology graduates would have to unlearn methods that prevailed elsewhere, such as the Brohm Site, where soil was simply spilled off a long-handled shovel in hopes of seeing artifacts as they fell (Hinshelwood 1990), or on Emerson's "big digs." There, as one student explained, "We are given a number of squares to dig. Since we know that we are on an Indian site, it follows that everything we find is an artifact. All we have to do is gather everything up and put it in a bag" (Lee 1983).

At Sheguiandah, the volume of material alone was such that artifacts -- stone that had been deliberately shaped or modified by man -- would have to be distinguished on the spot from objects to be discarded. Unmodified quartzite flakes were so numerous -- Lee thought they would run into the millions -- that they could not be collected, only sampled. The central pieces of stone that flakes had been struck off of -- "cores" -- were also discarded, except for representative samples.

In the Habitation Area, the cultural material -- stone flakes and stones shaped by man -- was so thick in the upper 10 or 15 cm of soil that trowels could not be used without disturbing artifact and chip associations (Letter: T.E. Lee to B. Ackerman, 21 June 1952). Instead, after lightly raking away leaves and twigs, the crew used grapefruit knives and paintbrushes to remove soil and debris from the masses of quartzite flakes and artifacts. Lee made photographic records of each artifact and chip cluster in situ (Figure 2.3). The horizontal position of every artifact excavated was recorded with respect to both the north-south and east-west trench margins, and its vertical position was measured to the nearest half-inch from both the actual soil surface and a theoretical datum plane.

Figure 2.3. As clusters of chips and artifacts were exposed, Lee recorded their positions and photographed them before allowing their removal.

As artifacts were removed from the ground, they were examined and washed. The triangulation data was recorded next to an outline sketch of each specimen, but the field-cataloguing proceeded by lots of up to one or two dozen specimens -- the groupings uncovered by excavation -- in chronological sequence (Figure 2.4). Chips of quartzite -- almost the only type of stone the Indians used here -- were set aside. Then each flake was subjected to close examination, and tested by feeling the edges, for use-wear, with only small samples being retained.

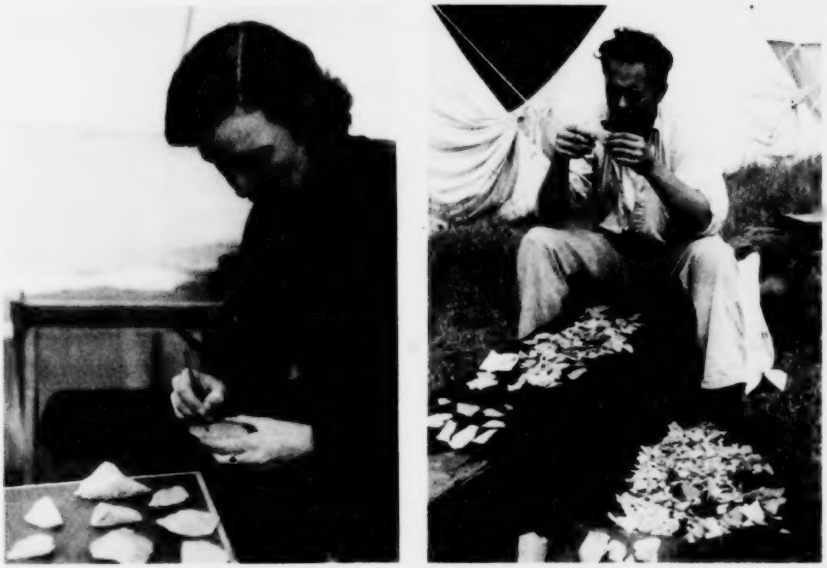


Figure 2.4. Man-made chips were so numerous, running into the tens of thousands, that, after examination, most were not kept. On the right, Ken Dawson sorts out those that showed signs of use as small tools. Left: Kaye Price labels and field-catalogues specimens that had been worked into some definite shape or purpose.

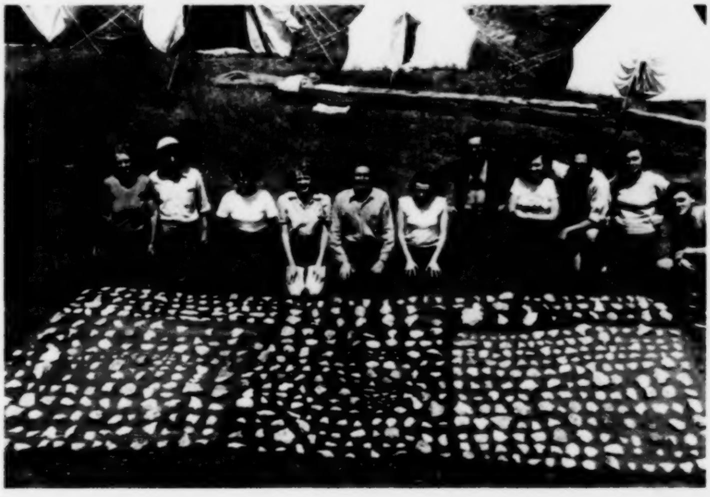


Figure 2.5. Lee (at center) and his crew assembled for the photographer with the 540 surface finds of their first three days. Left to right: Mary Dawson, Elizabeth and John Macdonald, Winifrid Blair, Barbara Bennett, Thomas Lee, Claire Shoniker, Bill Taylor, Vivian Barrington, Ken Dawson, Kaye Price, Jim Wright.

Because of office politics in the National Museum, the final step -- incorporation into a permanent catalogue system -- was never carried out, and to this day the artifacts are identified only by their field catalogue numbers. In Lee's system, a label such as O-Ma^{V}1-1127 for instance, would be read as Ontario/ Manitoulin District/ village site #1 (= Sheguiandah Site)/ 1127th entry. Often the soil context and depth were written right on the specimen (H = humus, T = "transitional").

After field study in the laboratory tent, specimens were individually wrapped in newspaper, packed with care in sturdy wooden crates, and shipped by truck or train to the Museum building in Ottawa, where they would remain unopened until Lee himself arrived.

In the interests of detecting stratigraphy, and anything that might have disturbed it, the soil and its variations were described as to colour and texture. The distribution of different sediments was recorded on the floor plans, which were redrawn after every inch of excavation, and profiled on each of the four trench walls. Soil samples were taken from the principal deposits, as well as intrusions and inclusions within them. To pick up signs of old tree-falls from previous forests, Lee (1954b) chose large excavation units 10 feet square (approximately 3 m to a side).

Areas that seemed less rich were purposefully selected for excavation, saving the more promising ground "until experience could teach me the best methods of handling the problems" (Letter: T.E. Lee to K. Dawson, 28 Sept. 1952).

In the Habitation Area, for instance, the initial excavations ringed an outcrop of quartzite around which disturbance from the toppling of poorly anchored trees could be expected. The squares were numbered as they were opened, so as not to lose time laying out a large and probably never-to-be-used, predetermined grid. Each was referenced instead to widely spaced stakes (or crosses cut on boulders) -- "stations" -- that had been surveyed in along an east-west baseline running over the hill. In 1952, the first five such squares were opened. Stations 7-1 through St. 7-5 were dug to depths ranging from 10 to 68 cm (Lee 1954b).

For the same reason, a second excavation area was opened on a patch of quarry rubble away from the Habitation Area. Here new crew members would have a chance to learn what they were doing without missing small artifacts or inadvertently destroying evidence of stratigraphy. Three large, adjoining "squares" with slightly differing orientations were laid out to fit the topography of the "Hillside Dump": HD 1, HD 2 and HD 3. Excavation was by hand-sorting of quarry debris and artifacts, until at about 80 cm depth, soil began to fill the air spaces in the rubble. At that point, hand tools were once again employed. In HD 2, excavation was discontinued at about 30 cm depth, but it proceeded to bedrock in the other two squares, at final depths of 1 to 1.5 metres.

For the entire crew, familiarity with the materials to be encountered in digging was first gained by extensive surface collecting (Figure 2.5). Out of urgency, these finds were recorded only as to general sections of the site, such as Upper Terrace. After bitter experience elsewhere, Lee (1954b) feared that the specimens would soon disappear to tourists and relic collectors.

Looting and the Law

At this time there was no law protecting Indian sites in Ontario. A crying need for such legislation had long been recognized: "For 50 years professional archaeologists have broken their hearts on this question and lost," said Lee (Letter to H.L. McDonald, 19 Aug. 1952), after reading the old reports and discussing the situation with the now elderly Wintemberg. At Sheguiandah, anyone could have ripped into the ground and walked away with whatever they wanted. And Sheguiandah was ripe for the picking. The abundant, gleaming white artifacts would tempt anyone who recognized them.

As Lee (1953) had immediately realized, the site lay astride the main highway on Manitoulin Island, "over which have passed thousands of tourists as well as archaeological survey parties from the University of Michigan." It was inevitable that interested people would come, once the discovery became known. It even extended down the slopes into village people's back yards. Access was easy and uncontrollable.

It seemed that all he could do was to keep quiet about the site as long as possible. Lee didn't even tell his foreman, Bill Taylor, where they were to dig or what, until the day he arrived. The camp was raised only at the last minute, and it was placed far enough away from the site to avoid giving it away. The crew would go to work each day along hidden footpaths newly cut through the woods.

Of course, a scientific party of 25 cannot be kept secret for long. Within days, articles announcing the discovery appeared in the "Manitoulin Expositor," Toronto's "Globe and Mail," and "Time Magazine."

As the summer progressed, more and more visitors, many from the United States, found their way to the Sheguiandah camp. Few made it onto the site proper. Most respected Lee's uncompromising stand on keeping the site closed to the public. But he spent hours at a time fending off collectors. Some of them brazenly parked their trailers in front of the camp, intent on seeing which way the crews were going as they went out to work each day. They found local people to take them onto the site against Lee's wishes. They even said they would wait until autumn, if they had to, when Lee would have to leave. He began to think he would have to stay on alone in order to guard the site.

The impending destruction of a hitherto undisturbed site drove Lee to desperation. His Director, F.J. Alcock, had taken the stand that tourists should even be encouraged to carry away souvenirs, as a means of promoting their interest (Lee 1964a). In response to Lee's mounting alarm over the threat posed by collectors, Alcock (Letter: 28 July 1952) insisted that he forget about protecting the site and "trust" people.

Lee (Letter to F.J. Alcock, 31 July 1952) explained that he had talked it over with his crew and with visitors to the site, gaining support from Norman Emerson and promises of action from Clyde Kennedy, who was keen about archaeology and had good contacts, and from members of the OAS. People he knew "have long been incensed over the lack of legislation," he said, "and this site has stirred them as nothing else could." He made a final appeal to his employer. He was concerned, he said, "not alone with this site, but with the whole archaeological future of Ontario ... now is the time for protective legislation ... would it not be possible for you to recommend, support, or otherwise encourage the efforts about to be made?" But Alcock (Letter to T.E. Lee, 5 Aug. 1952) would have nothing to do with it.

Lee (Letter to F. Knechtel, 2 Aug. 1952) a civil servant who had been instructed not to even speak to a reporter without official permission, now openly risked his job to declare: "I am launching a campaign to present the case to the public and to push through legislation as fast as possible. If I am wrong, archaeology is going to take a fair shellacking, since every person in Ontario will know that there is no law to stop him from digging or dynamiting." "In years to come I may be cursed by other archaeologists for what I am doing. This is a chance I must take" (Letter to H.L. McDonald, 19 Aug. 1952).

Lee took one of the OAS volunteers, Glenna Woolley, off the work and set her up in the expedition's office tent. For many weeks, her skill with a typewriter and dedication to the cause sent Lee's letters flying in all directions. He wrote to the Premier, and to the local Member for the Provincial Legislature. He wrote to friends and corresponded with colleagues, acquainting them with the urgency of the situation and asking them to send in letters of support.

People responded. They felt as Glenna (Roberts 2001) did: "the threat to this unique site became for us as individuals and for the OAS as an organization a major incentive to press for protective legislation for all archaeological resources."

Writer Fred Bodsworth (1952) put together a major story for "MacLeans Magazine." In "They're Looting our History," he described how for fifty years the essence of Canadian history had repeatedly been lost to collectors and destroyed by tourists. He explained how Lee had tried to keep previous finds secret, and failed. "This time," Bodsworth reported, "he changed strategy. He practically invited looters to come right ahead -- and in so doing he hoped to stir up the public sympathy that would produce for Canada, or Ontario at least, a law that would curb the looters."

"He called newspapermen into his camp [and] told them frankly where the site was located. Tom's announcement brought the looting issue into the open. Other Canadian archaeologists, who had been plagued by the same problem for years and had stewed in silence, now spoke out strongly in Tom's support. Manitoulin Island residents ... began clamouring for Sheguiandah's preservation."

A reporter for CBC radio, Herbert McDonald (1952), described for his listeners how "the young diggers work in an atmosphere of tenseness. Already, some of the big-time collectors are on the scene." The summer would soon end, he warned, and "then may come a digging spree that will destroy all chance of ultimate investigation." And McDonald touched on a more sensitive aspect of the situation: "Even if some are archaeologists, they will take their specimens away, and experience shows most find their way over the border."

Lee's campaign swiftly gathered momentum, and by late August he was informed that the government intended to introduce a bill in the fall. Lee was asked to send in his own views to the office of Ontario Premier Leslie Frost.

Writing to Premier Frost's secretary, Lee (Letter to E.J. Young, 2 Sept. 1952) explained that he was looking for legislation that would enable archaeologists to give Indian and historic sites adequate scientific examination without interference from collectors, and preserve and protect the most important sites. "Because the Sheguiandah Site offers special problems, I am hoping that some particular reference can be made to it ... [for] here is one of the rare cases requiring special provision that artifacts not be removed from the surface."

Lee then made a dozen detailed proposals that would set up the machinery to coordinate the activities of professional and non-professional archaeologists, take the profit motive out of looting, and prohibit the unauthorized export of archaeological material "to the United States and other countries."

Finally, Lee recounted how members of the OAS had proved so valuable as working members of his Sheguiandah expedition. He foresaw that, as they acquired experience and knowledge, "they can be called upon in emergencies to salvage materials" when a professional archaeologist might not be immediately available. "We need their help, and I believe we can in turn contribute to their interests by supplying them with training in the field."

Meanwhile, the digging was going ahead. Lee, who was devoting himself to the campaign for legislation, felt isolated from the work. He had the crew call him up to the hill to photograph in-situ artifact associations, allowing him to stay on top of finds and developments, but he was sure the investigation had suffered. Still, he believed that the sacrifice was justified (Letter to K. Dawson, 13 Sept. 1952): "In my opinion, I rendered a much greater service down in that tent; shooting out letters that are getting positive results now." "I think my work on this problem will have far-reaching and beneficial results through the years" (Letter to R. Marshall, 9 Oct. 1952).

After the crew left, he did indeed stay on to guard the site, leaving only when driven out by hard frosts and the approach of snow in mid-October. And the necessity of staying provided him with the opportunity to work with a trowel himself. He dug into the bottom of the trenches, where his assistants said sterile subsoil had been reached, and thus had careful control over the challenging stratigraphic situation there.

Field Results and Interpretations

In the Habitation Area, Lee (1954b) reported, "careful examination of the trench profiles revealed no clear-cut stratigraphy" except for the lower limit of the humus layer; "we are forced to rely more upon superposition and to this end we must exercise great care in noting depths and indications of subsequent disturbances."

There were signs that some artifacts had been uprooted by falling trees, and that others had been buried in the fill of prehistoric pits. But still an exciting pattern emerged from the summer's work. A very few ("no more than three or four" -- Lee 1974a) specimens on or near the surface suggested a minor Point Peninsula presence, which Lee (1954b, 1963a) associated with a site of that culture down by the modern lakeshore.

About 4000 large quartzite "blades," which a few years later came to be called bifaces, were collected. Most showed only primary chipping. Those in the Habitation Area occurred mainly from the surface down to the bottom of the dark humus layer. With them were many small tools and used flakes. These showed that the site was indeed more than a simple quarry.

In midsummer the digging reached the bottom of the humus layer. And here, completely unexpected finds suddenly began to appear. "A brief note on rapidly moving events," he told Clyde Kennedy (Letter: 1 Aug. 1952): projectile "points are coming up in fine yellow-brown loess -- depth 4 to 5 inches [10 to 12.5 cm]." In these, Lee saw Archaic forms and Paleoindian characteristics, the latter possibly 8000 years old.

The "fine crumbly, sometimes powdery soil" associated with the projectile points, was "so thin ... that it is difficult to define its exact limits" (Lee 1955a). Variously described as yellow-brown, buff-orange (Lee 1954b), and buff coloured (Lee 1957), this material was distinct from both the dark humus above and the reddish sediments below. Because of this, it was described as both "intermediate" and "transitional" in the field notes, with the latter label soon being adopted.

Not only did projectile points consistently come out of the same deposit, but even broken pieces that could be fitted together lay at the same level, despite their sometimes considerable horizontal separation. The base and tip of the first specimen lay about 10 cm apart. Parts of another were horizontally separated by an impressive 4 metres (Lee 1954b). Considering it impossible that these could all have worked their way down to the same depth, he believed that "we have eliminated any chance of [these] filtering down" (Letter to C. Kennedy, 1 Aug. 1952).

Within weeks, Lee (Letter to C. Kennedy, 10 Aug. 1952) was excited to see that the crew was "finding big blades -- better chipped -- under the level of projectile points in yellow-brown loess!" "These are not as big, are thinner, have secondary retouch along the edges, and are more pointed" (Letter: T.E. Lee to C. Kennedy, 18 Aug. 1952).

"At this point," said Lee (1954b), "the question of the origin of the soils and gravels containing human traces began to take shape." He could see that some natural force had buried the artifacts, but could not say what. John Sanford, head of the Geology Department of Wayne University, now happened to visit the site. After a preliminary inspection of the profiles, he told Lee that "the deposits have the appearance of glacial till and might be so described, if it were not for the presence of cultural material in them" (Sanford, in Lee 1954b). He took two samples of the sediments and later had them analyzed by his students.

Lee was inclined to accept Sanford's identification of the material, but believed that it "must ... have been a reworked deposit. Otherwise, there would not be quartzite chips [and artifacts] in it .... I lean more and more to the idea that this …is water deposited" (Letter to C. Kennedy, 18 Aug. 1952).

Sanford stayed for ten days, "trying to determine whether this really is water-deposited material" (Letter: T.E. Lee to A.J. Turnham, 18 Aug. 1952), or the product of chips having been dropped on a gradually accumulating surface, and buried by rain-wash (Letter: T.E. Lee to C. Kennedy, 20 Aug. 1952).

In the last days of the summer, Lee (Field Journal, 25 Aug. 1952) "punched a hole down about five feet [1.5 m]" in St. 7-4. Sanford, on viewing this section, said again that this deposit "would be called glacial till by any geologist at a glance" (Letter: T.E. Lee to F.J. Alcock, 27 Aug. 1952).

Finally, Sanford turned his attention to old lake levels, locating "the main Algonquin beach at about 1000 feet [305 m] some miles away. He will then work out the other major terraces and will try to tie them into our site" (Letter: T.E. Lee to F.J. Alcock, 22 Aug. 1952).

Before he left, Sanford "established a definite wave-cut notch with heavy, well-developed gravel beds and bars at a level of about 640 feet [194 m] on our site. None of our cultural material occurs below the top of this wave-cut bank" (Letter: T.E. Lee to F.J. Alcock, 27 Aug. 1952). "The hilltop was an island when occupied," Lee concluded (Letter to W. Ritchie, 2 Oct. 1952). "Some waterworn blades were found [there]. One seems to have been sandblasted instead. Sanford said in either case it would indicate a beach."

Sanford had told Lee he thought an estimate of 5000 to 7000 years was too low for the site. "He is continuing his studies on the problem [at Wayne University] and will later on make an announcement" (Letter: T.E. Lee to W. Ritchie, 2 Oct. 1952). Yet many months later he still had not reached a satisfactory conclusion: "I hope to have at least a working hypothesis before summer," he said (Letter to T.E. Lee, 30 Apr. 1953).

Meanwhile, the Hillside Dump had revealed unexpected depth. The broken rocks that were the debris of prehistoric quarrying lay a metre and more deep, with bifaces and other tools scattered among them. "Experts said superposition could not be used here ... my answer," said Lee (Letter to D. Josselyn, 22 June 1963) "was to take exact depths and exact positions for each artifact." Underneath the rubble was red clay in which were found chips and a few of the more finely flaked bifaces. "Here, then," said Lee (1954b), "is actual stratigraphy in support of the superposition indicated." The red clay lay in contact with quartzite bedrock that was itself a manmade surface. It turned out that HD 1 had been staked out directly above an astonishing prehistoric quarry pit, 3 m x 4 m, that had been worked straight down into the tough quartzite bedrock (Figure 2.6). The quarry, Lee reasoned, would have been the work of the group responsible for the finer bifaces, and it was subsequently filled with the rejects and debris from a later quarry close by and above it, "presumably cut by the makers of the big blades of the upper level."

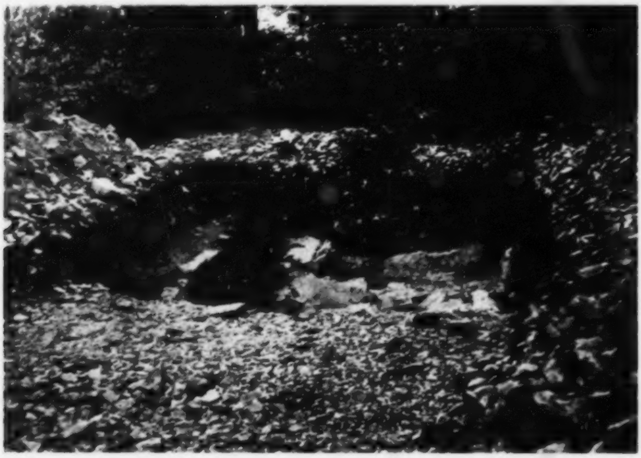


Figure 2.6. Piece-by-piece removal of prehistoric quarry debris on the surface eventually revealed another, older quarry, 3 x 4.2 m, cut into the quartzite bedrock underneath.

Thus, in a single season, the Sheguiandah Site had demonstrated far more depth, both in space and time, than Lee could have anticipated. Geological dating methods could now be applied, for the "big blade" material was abundant only above a well-developed wave-cut notch that must have been produced by a high lake stand.

Given the same facts, however, the half-dozen geologists Lee consulted reached as many conclusions, with estimates ranging from 5000 to 10,000 years. Archaeologists suggested dates from 400 years (Letter: E. Greenman to F.J. Alcock, 9 Sept. 1952) to 8000 years (Lee 1954b).

Lee had been at Sheguiandah for 119 days, from the 18th of June until the 14th of October, with a full crew for two months of that time.

The Second Sheguiandah Expedition: 1953

Lee's satisfaction in knowing that protective legislation would soon be enacted was gradually replaced by unease. Taylor (Letter to T.E. Lee, 4 Oct. 1952) had reported that on arriving in Toronto after the field season, "I was quizzed about the act [and] Greenman ... [Norman Emerson] felt you were trying to bar American institutions in toto." It was rumoured that Greenman was coming to Toronto to confer with Canadian archaeologists about his prospects under the new law.

One of these men warned Lee that it was dangerous to have gone to the public, and that legislation was not the answer to saving sites. "If [these] views are representative of Toronto, then there isn't much hope .... In their efforts to protect the learned Michigan scholar and other American interests [the proposed legislation] may be deprived of the teeth necessary for enforcement" (Letter: T.E. Lee to C. Kennedy, 2 Feb. 1953)

When Bill 66, *The Archaeological and Historic Sites Protection Act, 1953*, was passed, Lee was shocked. "Almost all of my suggestions were disregarded -- and in their place is a vaguely worded and poorly drawn up act that cannot work ... there isn't a thing in it that would require any [foreigner] such as Greenman to obtain permission to dig here or report their findings." (Letter: T. E. Lee to C. Kennedy, 7 Mar. 1953).

By the time he reached Manitoulin, it was further apparent that Sheguiandah was not even going to be covered under the new law. There was consternation in some quarters: that site, said MPP J. Fullerton, "was one of the main reasons for the passage of the bill" (Kenyon 1953). Lee fired up a second letter-writing and media campaign (Anonymous 1953). After interviewing archaeologists around Toronto, Kenyon reported that the obstacle was "jealousy among archaeologists ... one expert [challenged:] 'Lee says it's 5000 years old. Let him prove it. If the site was not recommended for protection, I should say it was because the [advisory] committee didn't think it was important enough.'"

Goals and Methods

In 1953, Lee was limited to a crew of 15, but many of them had already been trained to his satisfaction the previous year. Jim V. Wright was foreman. They were looking even more determinedly than before for adequate radiocarbon-dating samples; tiny fragments of charcoal "seldom larger than a match head" were scattered all through the deposits (Lee 1955a). By his estimate, pooling all the fragments from a single level of a 10-foot square would yield only 2 or 3 grams of charcoal (Letter: T.E. Lee to H. Suess, 12 Jan. 1955). Even that was too little for the methods of the day, but it was still painstakingly gathered and saved in hopes of future technological improvements. All these samples seem to have since vanished from the collections.

That summer, well-known amateur archaeologist Fritz Knechtel (Figure 2.7) four prominent archaeological sites around Ontario, to make a personal "evaluation of variance in techniques [and] procedures" under Lee, Greenman, Emerson, and W. Jury (Letter: F. Knechtel to T.E. Lee, 12 Aug. 1953). Afterward, he supplied Lee with detailed notes on the methods he saw employed at each. Of Sheguiandah he had written:

> Procedure most exact. Mainly grapefruit knife and brush. Back dirt placed in pails and removed. Ten foot squares with one qualified leader to square and two to three working in squares [Figure 2.8]. Levels and walls kept carefully ... level was meticulously kept on diagonal check of ten-ft squares .... Half-inch levels [taken] on down with full note as to all factors kept for each square. Levels, place of artifact, ground characteristics etc fully recorded. Numerous photos taken. Material in bags as to levels (cloth bags). Washing and cataloguing of artifacts promptly attended to. Insistence of leaving artifacts undisturbed until fully checked, photoed when necessary, etc.

Figure 2.7. Thomas Lee discussing a quartzite artifact with Fritz Knechtel. Knechtel specifically assessed Lee's methods at Sheguiandah, calling them "most exact" and "meticulous."

At Greenman's George Lake site, by contrast, Knechtel had to find excuses for what he saw: "Either crew off colour for day or something wrong in procedure." "Work seemed to proceed on a five foot width of un-established length .... Saw no mapping of levels, artifacts etc. No photographs .... Members of party seemed to squat at will and scraped, pried, used point of trowel regardless of level or any endeavour to keep level."

In Knechtel's estimation, Sheguiandah truly stood out: "No where else did I see such care taken, as much secured in information, such record of detail, location, levels etc. Norm Emerson's procedure ... would be the nearest approach." And Emerson was bagging everything by six-inch level. Jury's trenches were dug top-to-bottom all at once.

Digging again in the Habitation Area, the crew reopened squares 7-1 (Figure 2.8) and 7-2 and deepened them to completion, as it was then understood, at 65 and 37 cm. Station 7-6 lay over a quartzite outcrop and needed no excavation; squares 7-7 and 7-8 were opened close by, to the east and north. They were dug to 37 and 45 cm.

In late summer, drought gripped Manitoulin Island, and the small swamps on the hill dried out. Seizing a rare opportunity, Lee dug a small test trench in Swamp 1, about 65 m northeast of the Habitation Area.

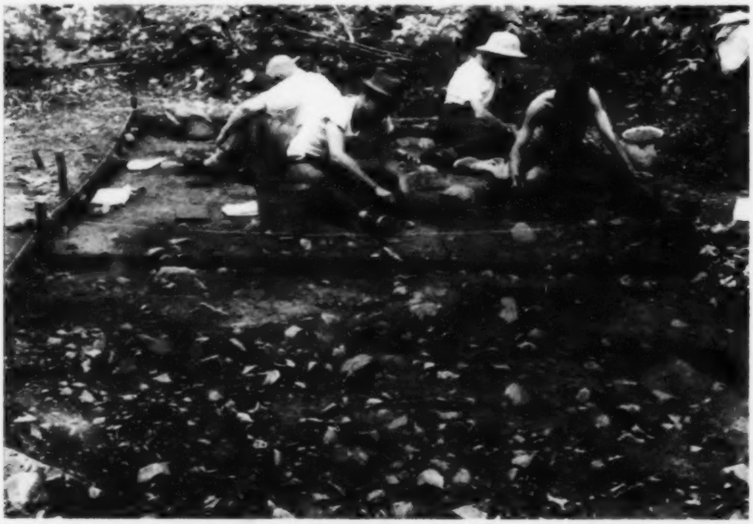


Figure 2.8. Looking west to crew of four working in St. 7-1. Note the use of small hand tools -- grapefruit knives and paintbrushes. Left to right: Alan Hodgins, James Fairburn, [identity uncertain], David Baird.

As the site remained at the mercy of collectors, "considerable" surface collecting continued. So vast was the site that even at the end of the previous season, Lee (Letter to H.L. McDonald, 7 Sept. 1952) had reported: "The material is still prominent on the surface despite our utmost efforts ... I cannot thoroughly surface collect [the site] and even if I could, I would be doing real harm to the scientific purposes I have in mind."

Field results and Interpretations

The season's fieldwork produced supporting evidence for the sequence of cultures previously described. Under the big bifaces, more projectile points had been found, most of them again at the 15-cm level.

The deposits below the projectile-point level received special attention. Flakes with bulbs of percussion and artifacts "occur in haphazard fashion throughout a deposit ... made up of clay, sand, gravel, pebbles, and boulders up to 2 feet in diameter. It is not believed possible by the writer that they could have been placed or thrown there by Indians in the course of camping, hunting, or quarrying" (Lee 1955b).

Sanford (in Lee, 1955b) returned and gave the deposits more thorough study. In the lower part of an incomplete section were clays he thought represented a glacial lake, most likely Lake Algonquin. Above them were the artifact-bearing sediments of uncertain origin. "The heterogeneous material with boulders which resembles till ... is extremely difficult to explain. On examination in the field, it appeared to be ice-deposited material."

After considering and rejecting both ice-rafting in a post-glacial lake, and deposition by mudflow, he suggested that a very local readvance of the glacier might have destroyed a small camp left by early Indians, close to the ice front, and tumbled the material forward a short distance.

"He said, quite calmly to me," remembered Lee (1976b), "'this is glacial till in primary position.' This was an utterly fantastic situation. I was bowled over.... All the books said that glaciers destroy all traces of man in their path. And he was telling me that I was getting artifacts out of glacial till. Should I believe him or not? I was still puzzled."

The swamp excavation also posed interesting problems. Not only were artifacts found at the bottom of the peat, as expected; they were also found in clay deposits underneath it. The way artifacts within the peat, or lying at its bottom, had caused the coloured bands of subsequent peat formation to conform to their presence showed that they had not been thrown in at a later date and sunk through water-soaked beds. Neither had these coloured bands been broken by artifacts sinking through them.

As well, "large thin blades were lying in flat positions on or in the clay. Even if they had settled through the peat, surely a little peat would have been carried along under them, especially where the under surfaces were irregular and jagged. Care was exercised in removing each specimen, but no peat was found under them ... the case is even better, of course, for the specimens found entirely embedded in clay (Lee 1955b)."

Furthermore, the quartzite artifacts found within the clay "retain their original clear light color, whereas every specimen from the clay surface or out of the brown peat is deeply stained"

(Lee 1955b). This he took as additional evidence that such artifacts had not sunk down through the peat into the clay.

The significance of these observations was related to the question of whether the artifacts had been deposited with the clay, or had been added to it in later times. The clay appeared to be lake-bottom deposits, and the only source then considered was glacial Lake Algonquin. The inclusion of artifacts within it suggested man's presence either before such a lake had formed, or during it existence.

Lee had been in the field at Sheguiandah from the 16th of June until the 30th of September, or 107 days. He now had two more lines of geological dating that could be applied, if the relationships between man, the swamp clays, and the last occurrence of ice at the site could be understood.

The Third Sheguiandah Expedition: 1954

In Lee's province-wide surveys, which he continued in the months before and after each season at Sheguiandah, he was gathering evidence that Sheguiandah was not a quarry along classic lines, in that the big bifaces seemed not to have been carried away for finishing into tools elsewhere. He began working with thin-sections of quartzite, to establish their sources by microscopic examination. Presently he was able to state that "quartzite chippings and specimens ... in this particular kind of quartzite do not occur ... on any of the hundreds of sites I have personally examined. Neither are they found in the several hundreds of collections I have examined in Ontario" (Letter to D. Wenner, 8 Apr. 1954).

Lee began to doubt that the bifaces were even quarry blanks at all: "After one year of studying this problem,' he said, "I began to see that a great many of the objects classed as bifaces, unfinished, were actually nothing more than cores, discarded while still 6, 8 or 10 inches long. When I tried chipping out those big bifaces, I discovered that the flakes were coming off at an angle such that thick bifaces could result, and even some impressive tools, too. It took the big stuff to make me see this. Hell -- I had even gone so far as to set up a classification based on outline, shape! -- when I was actually handling cores, in many cases. They did look like bifaces, and I was not the only one fooled" (Letter to D. Josselyn, 6 Mar. 1965). "It is becoming evident," he said in this connection, "that some tremendous activity was in progress at Sheguiandah, other than quarrying" (Lee 1964b). He came to agree with the thesis, presented by Kirk Bryan (1950) that the product exported from quarries like those at Sheguiandah was not stone, but wood that had been worked on with stone tools. Wood is a relatively lightweight material that is easily traded, but seldom leaves a trace.

In the spring of 1954, the Archaeological Sites Board finally listed Sheguiandah as a protected site, and Lee's request for permission to dig there was granted (Letter: W.J. Dunlop to T.E. Lee, 6 Apr. 1954).

With authority over the Sheguiandah Site, Lee now felt safe in conducting public tours there, and led groups of schoolchildren and members of the local Chamber of Commerce, 50 at a time, over the site. When the crew arrived, he would have them set up displays at the campsite. A thousand people would come to see Sheguiandah in the course of the summer.

Goals and Methods

During the months leading up to the 1954 expedition, Lee consulted with members of the Geological Survey of Canada about the Sheguiandah Site deposits, and corresponded with Lyman Chapman, who had coauthored "Physiography of Ontario," as well as Sanford. Chapman (Letter to T.E. Lee, 21 Jan. 1954) identified the wave-cut notch that defined the site's limits as a Lake Nipissing feature, about 5000 years old.

Lee inferred that this was the age of the "big-blade culture," because their artifacts did not occur any lower than the notch, but by the end of the season, he could no longer support this view with his original assumption that certain curiously worn specimens from the site were wave-rolled. Three years earlier a quantity of rejected chips and cores had been dumped into 3 m of water in Sheguiandah Bay. By 1954, many of them had been worked inshore by wave action and were recovered from the beach; this "experimental" material was available for comparison.

With regard to the controversial deposits on the hill, Chapman pointed out that high-level Lake Algonquin beaches to the north, in the Sudbury area (about 11,000 years old), had not been obliterated by any re-advance of glacial ice. Vic Prest, of the Geological Survey, was also skeptical that the deposits could be glacial till from a re-advance.

Presented with these arguments and opinions, Sanford was troubled. "The material certainly looks as though it had been moved by ice," he said. "There must be some factor or some bit of evidence which has so far escaped us" (Letter: J.T. Sanford to T.E. Lee, 23 Mar. 1954).

In June, Lee reopened the old trenches and Sanford brought in a busload of geologists from the Michigan Geological Survey. "First thing I noticed," said Lee (Letter to D. Josselyn, 5 July 1963), "was an interesting little quiz put on by Dr. Sanford ... [he told them:] 'Get down in that trench and tell me what those deposits are.' Reply, 'No need to get in the trench -- they are obviously glacial till in primary position.' 'Are you sure of that?' Reply, 'Absolutely!' 'Get some of it in your hands for a closer look. Are you still certain?' Reply, 'Of course! It cannot be anything else.' 'But there are human tools in it and under it!' Reply, 'Oh, then it cannot be glacial till!'" Sheguiandah had been scheduled as a 15-minute stop, but from that point on, heated arguments raged for hours over the issue (Letter: T.E. Lee to F. Knechtel, 3 July 1954).

Bruce Liberty of the GSC, with his assistant Frank Abbott, then came to the site. He was excited by what he saw, and quickly made Sheguiandah a focus of his own work on the Island, visiting almost daily in an attempt to unravel the growing mystery there. "Every detail of the investigation came under [his] careful observation," said Lee (1955a).

At times, Lee would halt the digging so that the geologists could see significant features on their next visit. He readily complied with their requests to dig trenches, often where no archaeological information could be expected at all. Together, Lee and the geologists also explored the various islands and shores in the region, looking for ancient beaches, sites, and other features that would help with the interpretation of Sheguiandah.

Other visitors, such as Chapman, who spent three days on the site with Dr. Gorman, both of the Ontario Research Foundation, also requested that geological trenches be opened. One of these was dug down to bedrock in the northeast corner of Station 7-8, exposing a face 135 cm wide and 210 cm deep. "I shaved this profile myself with a very sharp trowel," Lee said, (Letter to L.J. Chapman, 19 Sept. 1954), "and then traced every color and change visible, including every one of the hundreds of varves visible in the bottom three feet." "I spent two days getting this graph alone -- I'll swear to its accuracy" (Letter to J.T. Sanford, 18 Oct. 1954).

From this vertical face, Lee (Field Journal, Sept. 9-11, 1954) took soil samples for Liberty, at 1-inch intervals. This was a departure from his usual practice, carried out each year in many of the trenches, of sampling from discrete soil units.

Lee's crew had again been limited to 15 people, too few to throw their weight into his major project, the excavation of the swamps, but he counted himself fortunate in having a new foreman, Walter Kenyon, who won his respect and admiration for "the ability to think his way through problems beyond his experience" (Letter: T.E. Lee to E.S. Carpenter, 19 Nov. 1954).

The specific goals in 1954 were: to achieve a better understanding of the presumed glacial deposits; obtain samples for radiocarbon and pollen analysis; and to better understand the relationships between the swamps and man (Lee 1955a).

Resuming work in the Habitation Area, two new 10-foot squares, 7-9 and 7-10, were opened next to the old squares and dug to depths of 54 and 74 cm, respectively. Two smaller test squares, each 5 feet square, were opened. One, St. 7-B, was about 10 m to the SW of the main excavations; the other, St. 8-A, about 10 m to the east, was dug to a depth of 83 cm. Below 45 cm, digging in St. 8-A was by shovel and mattock, for geological information.

Following discussions with half-a-dozen soil specialists as to why no bone was being found in a place where people must have lived, Lee tested the Habitation Area soils for pH using a colorimetric method. Liberty and Chapman carried out similar tests of their own.

An 11-metre-long, 1.5-m-wide trench in Swamp 1 (SA 1 TP1) was run northward into the swamp from the spot previously test-pitted, and a similar east-west trench (SA1 TT2) was cut to intersect with it out in the middle of the swamp. A 5 x 5 foot extension was made to include a large boulder sitting in the swamp. To have a place to temporarily store the peat and other materials, an area of about 4 x 6 m on the south shore was cleared down to bedrock. To see if the clay bottom of the swamp could be correlated with the clay deep under the Habitation Area, a 13-m long trench, 1.5 m wide, was run in that direction over the top of the Middle Quarry Ridge (MQR) from the south edge of Swamp 1.

The three other swamps on the hill were also test pitted. In these places, pick and shovel were used to remove the peat, after draining the swamps by siphon and by bucket brigade; other sediments were excavated by trowel. Swamp 2 was tested with a 3 x 6 foot pit, dug to bedrock at

135 cm. A 3 x 5 foot pit in Swamp 3 was dug to touch sloping bedrock at 250 cm, and could have gone deeper. Another 3 x 5 foot pit was dug to bedrock at 120 cm in Swamp 4.

Lee (Letter to L.J. Chapman, 19 Sept. 1954) drew profiles in all four swamps, "with all visible charcoal bands marked on, [with] note taken of any change in color, texture and density of the peat."

A bryologist, Howard Crum, sampled the peat for the identification of mosses. Lee collected peat samples from the swamps for pollen analysis by Jaan Terasmae, of the Royal Botanical Gardens in Hamilton. Preliminary results from the previous year encouraged him to take a complete suite of samples from Swamp 3, "at one inch intervals, from 100 inches up to the surface ... and some large samples of peat ... [I] intend to have the lower sample tested by C14 analysis." For both pollen and radiocarbon samples, Lee washed his hands and tools between samples, and, touching the peat only with the tools, placed the samples directly into either bottles or aluminum foil (Letter to J. Terasmae, 8 Dec. 1954).

Almost from the beginning of excavations in 1952, the essentially preceramic Sheguiandah Site had been downplayed by anonymous but influential critics as a mere Point Peninsula workshop. To show the contrast between these cultures and quell this continuing misrepresentation of the site, Lee now also dug a site of this culture just behind his camp, which had been discovered by his crew in 1952. He opened almost as much ground there as he was doing in the Sheguiandah Site's Habitation Area.

Field results and interpretations

The nearby site of the Point Peninsula culture that was dug for comparison (Lee 1963a) was predictably rich in pottery (which was entirely absent from the Sheguiandah Site) and chert fragments (rare on Sheguiandah). But interesting connections were noted, in the form of quartzite that had been brought down the hill to the lakeshore. Wherever an original surface remained, it was smoothed and rounded in a manner frequently observed below the Nipissing notch; "evidently random quartzite boulders and cobbles were used from the surface concentrations of the high Nipissing beach ... Point Peninsula people did not quarry the hill" (Lee 1955a).

Soon he had the satisfaction of seeing the conversion of "the most severe critic within archaeological and anthropological circles, one who has talked openly of my site as a Pt Pen workshop and hence only a few thousand years old. [He] has just left the site, a badly shaken man," said Lee (Letter to L.J. Chapman, 19 Sept 54).

Greenman too, visiting the site with Albert Spaulding, also of the University of Michigan's anthropology department, "tried to make out that this is a Point Pen site again -- I knocked him down in front of his students. He was seething, but couldn't do much. [He] treated my finds with contempt, until he saw the Folsom [projectile points]; then he swore" (Letter: T.E. Lee to F. Knechtel, 1 Oct. 1954).

The quartzite chips recovered from the modern Lake Huron shore after three years in the foreshore waters were found to have acquired "a gravelly appearance" (Lee 1955a). "All surfaces are battered and worn. When compared with the abraded specimens in question on the hilltop, the differences are at once apparent and conclusive." On specimens from the hill, the abrasion had a different feel and was not necessarily uniform, often being restricted to parts other than edges and points. Lee (1957) later declared that he had been "forced to abandon wave action as an explanation ... in view of the accumulating evidence against it."

On the Sheguiandah Site proper, excavations were concentrated in the Habitation Area and the swamps. In St. 7-9, a low ridge of reddish soil contained a heavy concentration of chips, mostly (68%) standing on edge. This was presumed to have resulted from a minor tree fall; minor, because it was small and did not appear to have gone very deep. "In terms of the vertical distribution of parts of broken blades which could be fitted together ... disturbance seems not to have gone below 5 inches [13 cm] depth" (Lee 1955a). In another part of the square, 40 of 41 chips lay horizontally. Lee (1955a) considered this the "normal mode of occurrence" in the humus.

Kenyon, in charge of this square, offers a fresh perspective on the site through his field notes, which are all the more valuable for the healthy scepticism he maintained. "He has been slow to accept my opinions," said Lee (Letter to B. McCary, 3 Sept. 1954), "questioning everything until satisfied with the evidence uncovered by himself." Although there was talk of till and glaciers all around him, Kenyon refrained from even using these terms in his notes until the very end of the summer.

After a week in charge of digging in the Habitation Area, Kenyon observed (Field Notes, 8 July 1954) that three-quarters of the 32 artifacts found in the humic layer had been associated with clusters of chips. "This would indicate a workshop," he reasoned. "But what of the scrapers? These indicate residence."

In St. 7-9, projectile points had been found at 7.5, 13, and 16 cm. Describing them, Lee concluded: "One resembles Scottsbluff and another is the nearest thing we have to Folsom thus far found in Ontario." A third also had Folsom characteristics (Letter to F. Knechtel, 2 Aug. 1954). Such points "would automatically place the site in the Paleoindian period, about 8000 years ago" (Letter: T.E. Lee to F.J. Alcock, 19 July 1954). Other specimens seemed to be Early Archaic.

As the crews dug into the reddish soil below, Kenyon (Field Notes, 29 July 1954) noted that "the heavy concentrations of chips end with the transitional." Flakes were now scattered and scarce. There were large, thin bifaces with secondary chipping along the edges. Most were broken; "they occur in scattered fashion throughout the deposit, forming no pattern, and lying at any angle" (Lee 1955a). Flakes, too, were oriented at any angle. Of 22 examined with this in mind, about half were less than 45° from the vertical, and half more.

Kenyon (Field Notes, 19 July 1954) had further noted: "as we proceed downward ... it becomes increasingly apparent that we are not dealing with one cultural deposit. The transition is too complete and too abrupt. On the whole, the blades at this level are smaller, projectile points are absent (as they were at the very surface), prismatic and lamellar flakes seem to have vanished, and the number of scrapers is extremely low."

"Artifacts continue into the red at a rate and depth that precludes their having been pressed down accidentally ... [I am] still seeking, unsuccessfully, signs of disturbance" (Kenyon, Field Notes, 29 July 1954). "No sorting of materials is evident: large boulders, ca. 25 lbs. [12 kg], are scattered at random. Smaller ones, down to tiny pebbles the size of a bean, are scattered among them. Every intermediate size is present" (Kenyon, Field Notes, 2 Aug. 1954).

"In my own experience," said Kenyon (Field Notes, 3 Aug. 1954), [there is] no possibility of this being culturally deposited material." He concluded that "the only tenable explanation is that [the] chips and artifacts encountered at this level [were] deposited by whatever agency is responsible for the distribution of the boulders and pebbles."

Chapman (Letter to T.E. Lee, 2 Sept. 1954), after examining this and other sections, offered a tentative summary: "The soil ... appears to be a loose, sandy till, containing many stones and boulders of all sizes." But in his view it could not be as the ice had left it: "I think that ... the upper 24 inches [61 cm] are ... wave worked material." His reasoning was that the glacial ice could not have readvanced after Lake Algonquin.

To account for the embedded artifacts, he suggested instead that Lake Algonquin had dropped far enough to uncover the site and permit occupation, and then risen again, repeatedly. Acknowledging that "there seems to be no geological evidence [for this] at the Sheguiandah site," he proposed that the man-made materials had instead been dropped in shallow water, originally: "it would account for the artifacts being buried."

About 43 cm down, patches of sand and of gravel began to appear in what Kenyon had been describing as an "unbroken red soil." Some of these were described by Lee (1955a, 1957) as small, thin, horizontal lenses of fine material that seldom exceeded 45 cm diameter. "Gravel lenses encased in the till," he later learned, "must be in original position in the till." This, Ernst Antevs said (Letter to T.E. Lee, 31 Mar. 1955), was his best evidence that the material had not been moved or redeposited. "No chips were found in such lenses," Lee said, but as had been seen the year before, "artifacts are on occasion 'sealed off' under [them]." This circumstance, in Lee's view, precluded post-depositional disturbance as an explanation for the artifacts' occurrence at depth.

Other sandy inclusions were rounded in cross-section, "resembling disintegrated sandstone cobbles. These were examined by Dr. Sanford, who believes they represent instead blocks of sand deposited in a frozen condition" (Lee 1955a).

In both St. 7-9 and 7-10, the rounded patches of sand occurred "in greatly increased number" in the lower part of the till-like deposits, while the horizontal lenses were found only there (Lee 1955a). Kenyon (Field Notes, 13 Aug. 1954) had also noted "an increase in [the] number of pieces of shale" in the lower part.

Although Chapman (Letter to T.E. Lee, 2 Sept. 1954), after his summertime visit, had declared that "there is no visible layering" within the till-like deposits, Lee (1955b) had recognized a second cultural component in the lower half. Now it was becoming evident that there were upper and lower levels that could be distinguished geologically, as well as archaeologically. The occurrence of two relatively thin (20 to 30 cm) components to the till-like deposits became a point of great significance to Sanford (1971), who used it in vigorous argument against mudflow under the subtitle, "Why till and why two."

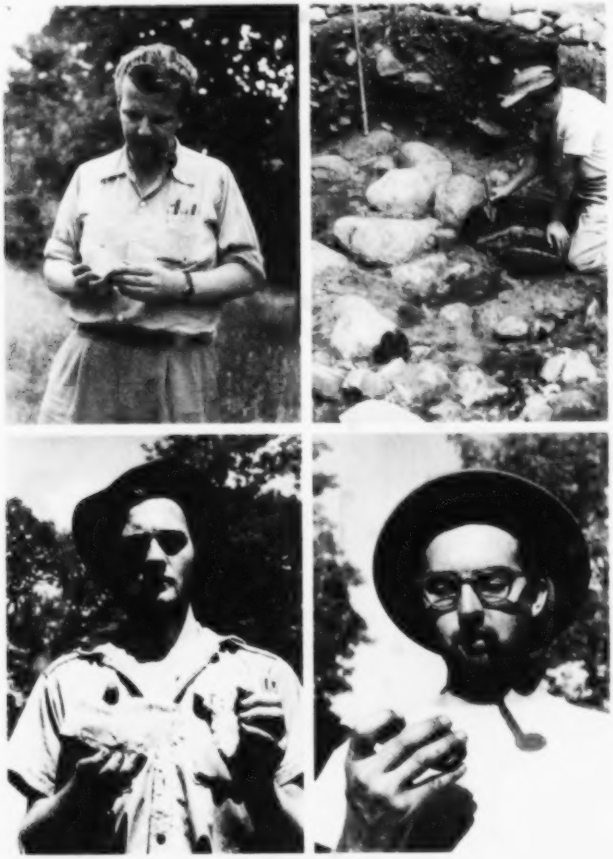


Figure 2.9. Amateur archaeologist Clyde Kennedy (upper left) took many of the photographs shown here (Figures. 2.1, 2.3, 2.4, 2.5, 2.7, and 2.11, as well as these three portraits): Thomas Lee took the rest. Walter Kenyon (upper right) works among the boulders concentrated just below the controversial till-like deposits, visible on the trench walls. Kenyon served as foreman in 1954; before that Lee had employed Bill Taylor (lower right) and Jim Wright (lower left). Like Ken Dawson (Figure 2.4), these three all went on to prominent careers in Canadian archaeology.

The material, said Liberty (1955), "is termed 'till-like' only because of the presence of enclosed artifacts; otherwise geologists would have no compunction about calling it glacial till."

At about 60 cm depth, the tops of large boulders began to appear all across the square, the interstices being filled with sand (Figure 2.9). Sanford's examination of the sand led him to call it a glacio-fluvial deposit. He explained to Kenyon and the crew that these sands and very fine gravels had washed right off the ice: people had lived right at the glacier's edge. V.K. Prest (in Lee 1957) suggested "probably they were deposited by small meltwater streams."

The boulders, as much as 60 cm across, nearly covered the bottom of Station 7-9. "Since some thrust up far above others, it is perhaps correct to refer to this as a boulder concentration," rather than a pavement (Lee 1955a). Where they were removed, in the east half of the square, hard-packed sands under them showed that the boulders had not been derived from the underlying deposits (Lee 1957).

In the small area dug at this depth (70 cm), only one artifact, a scraper, was found, but there were "several chips, regarded by the writer as definitely man-made ... they show bulbs and old flake scars" (Lee 1955a). Kenyon (Field Notes, 18 Aug. 1954) agreed, but asked, "Why do we find so many that, as yet, must be assigned to natural agencies? If they result from natural agencies, why are they all quartzite? Other stones are present!"

Excavations in St. 7-10 were supervised by Glenna Woolley. Having to leave in midsummer, she summed up the early results as they had developed there: "the superposition of artifacts seems to fall into the established sequence, with big blades predominant in the first 3 inches [7.5 cm] ... and secondary chipped blades ... from 4 inches [10 cm] downward" (G. Woolley, Field Notes, 1 Aug. 1954).

"Parts of the square," summarized Lee (1955a), "show considerable disturbance to a depth of seven inches [17.5 cm], as indicated by the fitting of the vertically distributed parts of broken blades"; these were associated with "a distinct surface ridge resulting from a tree fall" (Lee 1955a). "Other parts show little disturbance, as indicated by the positions of horizontally distributed parts of [four] broken blades," the pieces of which had been separated by as much as 45 cm.

Fragments of five projectile points were found in St. 7-10, two of which, though still incomplete, resulted from the matching of separated parts. They occurred at depths of 10 to 15 cm in transitional to red soil (Lee 1955a).

In the lower part of the till-like mass, lenses of sorted fine gravels and sands were again noted. Boulders were not concentrated in St. 7-10, and here the associated layer of sorted sand was patchy. Directly below much of the till-like deposits here were what Sanford considered "lake clays." A few chips were found at the boundary between the deposits. Digging into these clays, Lee (Field Journal, 27 Aug. 1954) was astounded to see "water worn man-made objects ... coming out of them!" A broken blade and several good chips were found solidly in the clay. But they were so "rolled" that Lee (1955a) considered it impossible to demonstrate to everyone's satisfaction that they were the products of man's work.

In the deep pit in St. 7-8 (Figure 2.10), the boulder concentration was pierced by the removal of three stones each 30 to 45 cm in diameter. Underneath the largest was "a chipped quartzite block and some chips" (Lee 1955a).

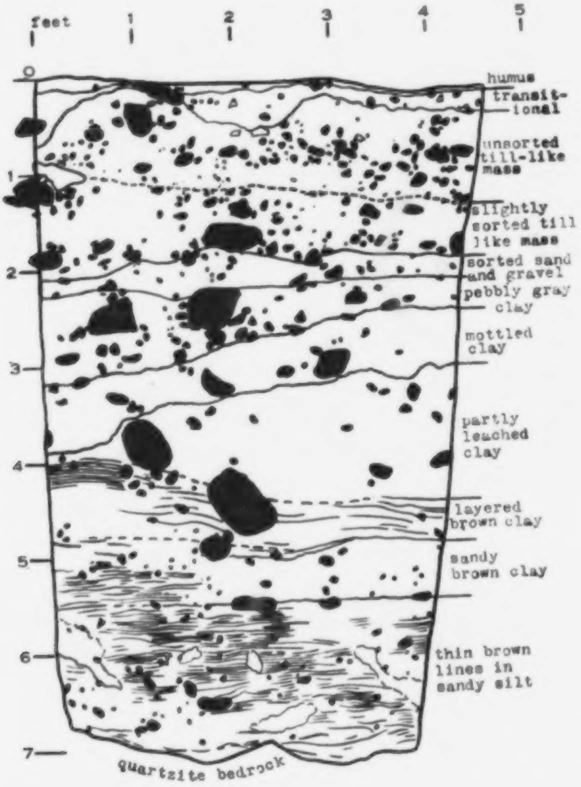

feet
1
2
3
4
5
0
1
2
3
4
5
6
7
humus
transitional
unsorted till-like mass
slightly sorted till like mass
sorted sand and gravel
pebbly gray clay
mottled clay
partly leached clay
layered brown clay
sandy brown clay
thin brown lines in sandy silt
quartzite bedrock

Figure 2.10. Lee drew his trench profiles so as to record all possible visual evidence. He required two days to profile this deep test pit that was dug to bedrock in the Habitation Area, St. 7-8. Artifacts occur in the upper 75 cm. Controversy has focused on the nature and age of the two till-like deposits, from 17 to 60 cm, but all the sediments have aroused interest.

The clays were mottled and pebbly in the upper half. Here the material was "notable for its composition of irregular patches of light-coloured powdery material throughout the very hard clay" (Lee 1955a). On the north face of the pit, "a curiously banded structure was observed, extending one foot [30 cm] into the pit [suggesting] varves." At 76 cm depth "some small chips, believed to be man-made" were found.

Below that, in the bottom 80 cm, the clays underlying the Habitation Area were increasingly laminated, yet there were "occasional angular chunks of clay" and "small patches of clear sand." At over 210 cm, the pit reached quartzite bedrock, which was glacially polished.

Lee (1955a) judged the two 5-foot [1.5-m] test squares to be too small for effective observation of soils, and considered that relatively little was learned from them.

The results of testing showed that soils near the surface of some parts of the Habitation Area were strongly acidic, with both horizontal and vertical variations from pH 4.5 to 6.3. This explained why, in a supposed Habitation Area, no bone had been found.

The hilltop swamps, small and vegetation-choked on the surface, but sometimes surprisingly deep, became the second major focus of the summer's work.

The area beside Swamp 1, which was cleared to hold the peat dug out of Test Trench 1, was found to be a mass of spalls, fragments and artifacts. These lay over a bedrock surface that rose and sloped again in a series of steps as much as 30 cm deep. Many of the bifaces were finely retouched along the edges. An unusual number of them had been broken and reworked. But it had been impossible to control the vertical positions of artifacts, and no conclusions could be drawn from the material.

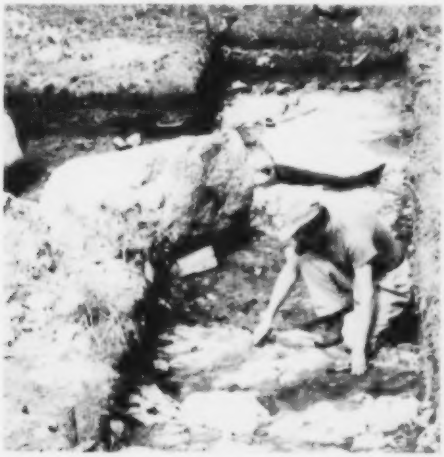


Figure 2.11. Walter Kenyon, cleaning the bedrock floor of Swamp 1. Note banded peat overlying artifact-bearing clay in the trench wall. The clay was in contact with bedrock, but was the boulder? Lee and visiting geologists split it and rolled the pieces away to find out. The smaller piece lies in the hollow of the angled step illustrated in Figure 2.12.

In the Middle Quarry Ridge trench, which began a metre out in Swamp 1, crests of "schist" (phyllite) bedrock higher up broke the continuity of the soil and precluded any direct correlation of swamp and Habitation Area clays. Where there was soil, there were also artifacts "all the way to the bottom" (Letter: T.E. Lee to J.T. Sanford, 14 Jan. 1955). Two geologists -- Sanford and

Liberty, as well as Chapman, a pedologist and physiographer -- all agreed that these deposits were glacial till.

In Swamp 1, TT1, clay was encountered under 35 to 46 cm of peat. Artifacts were found mostly on or in that clay, which itself was 10 to 15 cm thick, all the way "to bedrock" (Lee 1954c). Liberty and the other geologists were skeptical that the artifacts had been deposited with the clay, for they saw it as a deep-water deposit incompatible with man's presence. They argued that the artifacts had sunk through the forming peat in more recent times, and settled into a soft and yielding clay bottom. Lee had to show them evidence such as he had gathered the previous year, in terms of organically stained artifacts lying suspended between unbroken bands of coloured peat, unstained quartzite specimens embedded in the clay, and failure of the supposedly sunken artifacts to have carried any traces of peat with them into the clay.

The geologists were not easily convinced. Attention turned to a chest-high boulder out in the swamp, and they argued about whether it had sunk through the clay to bedrock. Measurement and calculation gave it a weight of four tons. With a jack and hand tools, Lee, Liberty, Gorman and Chapman broke and rolled it aside (Figure 2.11). No peat had formed beneath it; the boulder had been sitting directly on clay at least 25 cm thick, without having settled down to bedrock. Thorough examination revealed not even pebbles for the boulder to have perched upon. The geologists were now satisfied that the artifacts had been buried by the clay as it formed, however that had happened. There was a single man-made chip within the clay where the boulder had sat.

Removal of the clay revealed a bedrock surface that rose and fell in a succession of slanting steps and breaks. It had a saw-toothed profile, with the steep edges facing north, and the peaks level. Blocks and spalls of quartzite lay in the hollows. "In one such cluster of rubble and chips, tucked against a step, was a battered hammerstone. These obviously were in place before the grey clay accumulated" (Lee 1955a). There were percussion marks on the quartzite, as there were on other quarry surfaces elsewhere on the site. Lee concluded that Swamp 1 lay in a man-made basin cut by Indians using stone hammers before either the clay or peat had formed.

The three other swamps lay in pockets on the very crest of the hill. In Swamp 2, banded peat extended down 38 cm from the surface. A single biface was found on the underlying bed of clay. For 90 cm more, thin layers of sand and clay alternated (Figure 2.12). These lay horizontally, except where conforming to steep faces of bedrock. The quartzite floor of the trench was littered with boulders of quartzite and granite from 25 to 45 cm diameter; pockets of coarse and fine gravels occurred in one corner of the small trench. "Geologists present felt that 'glacial sands off the ice' had accumulated here" (Lee 1955a).

Swamp 3 proved to have the greatest depth, with about 120 cm of peat overlying successive beds of differently coloured clays. The peat itself was easily subdivided on the basis of colour and texture.

On profiles, the upper layers of peat contained at least 22 thin layers of charcoal, suggesting forest fires; the lower, fibrous peat yielded only scattered charcoal (Such details are not reproduced here). A section of a spruce log, chopped out at 90 cm depth, was submitted to the dendrochronology laboratory at the University of Arizona. At 125 cm, many seeds and seed pods were found. Botanical specimens were identified by W. Baldwin of the National Museum; insect eggs were noted on one leaf. At the same level, H. Crum obtained and identified mosses that are characteristic of the Arctic.

Terasmae's pollen analysis of Swamp 3 (in Lee 1957) charted the changing vegetation of the region through the postglacial millennia. He was able to show that the peat in the different swamps had experienced those changes in the same way.

The peat beds of Swamp 3 rested on an uneven surface of grey clay; "on the clay and within it were obviously man-made cores and chips ... at various points between [127 and 160 cm] ... some cobbles were also contained within the clay" (Lee 1955a). Still lower were deposits of brown and reddish clays, which contained patches of fine "sharp" gravels. At the deepest point reached in Swamp 3 (250 cm) a layer of sand and gravel of unknown thickness and context was touched.

In Swamp 4, geologists first attempted to bore down with an auger but were unable to break through a bed of "gravel." As excavations reached a depth of 58 cm, "the 'gravel' was seen to be a complete paving of artifacts and cores, resting on and in clay" (Lee 1955a). "Man-made chips continued through the underlying 9 inches [22.5 cm] of gray clay and sand. A gravelly clay was then encountered. Chips and cores were still fairly numerous. A layer of gravel below this, however, produced only two or three probable cores." Lee considered it significant that secondary chipping was present on some of the apparently unfinished artifacts found in the clays, and remarkable that there should be such an excess of cores over chips. "A flake industry is indicated; moreover, the cores were rejected as soon as very long and heavy flakes could no longer be removed."

Under the peat, the pits in these latter three swamps had revealed pockets and layers of gravel, sand, and clay that alternated in beds in a deposit up to a metre thick. Where clays were exposed, they were called glacial till by some (Lee 1957), but others said that the layers of sands and gravels indicated deposition by flowing water. Lee was told that the latter were probably glacial deposits "off the ice" and "right at the edge of the ice." Chapman (in Lee 1954c) remarked that "this site proves for the first time that man was living right on the edge of the glacier."

Terasmae, however, could not reconcile these views with his finding of fine plant debris in all the deep clay layers of Swamp 3. Although noting that till samples may contain microfossils, he felt that such material "is not characteristic of deposits of glacial origin (outwash) in this area" (in Lee 1957).

Swamps 2 and 3 lay in line with an anomalous dry ravine running westward along the crest of the hill. A bar-like formation at its outlet suggested water had flowed in that direction, and trenches were started where the ravine opened out on the side of the hilltop. Excavating there, Lee (1957) reported that "man-made chips and a few finished artifacts occurred to a depth of at least 16 inches [40 cm] .... all digging below this level was performed by geologists." Liberty (Letter to E. Antevs, 28 Feb. 1955) described the deposit as consisting of "large blocks [of shale up to 63 cm across] in a tumbled condition. Intermixed and covering [them] are stream materials,

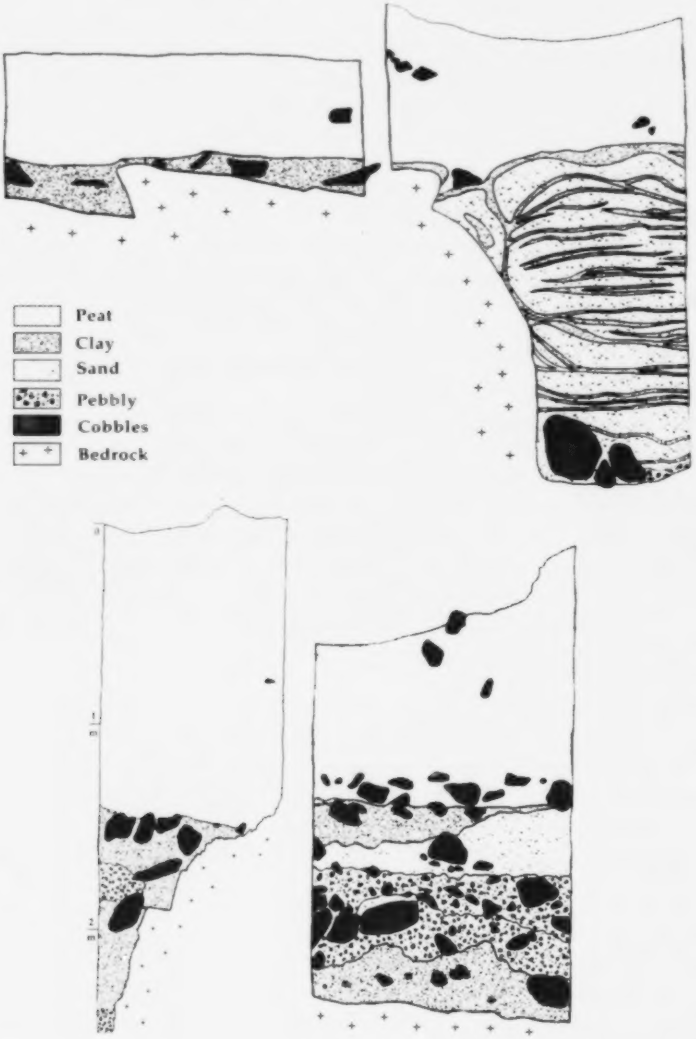


Figure 2.12. Profiles of trenches and test pits in each of the four swamp areas, simplified by omitting details in the peat (SA 1 and 2 top, SA 3 and 4 bottom; vertical scale indicated on profile of SA 3). Deposits of clay, sand, and gravel underlie varying thickness of peat, the bottom of which has been C14-dated to about 9500 years. These inorganic sediments were thought to have been deposited in glacial times, generally by or through water in conditions incompatible with man's presence, yet the upper parts of some of them contain artifacts. Lee considered the bottom of SA 1 to be an artificial surface, as it showed signs of quarrying. Profiles of SA 2 and 3 are looking toward the rush of melt water; SA 4, across.

gravels, boulders, cobbles, and a minimum of sand." It was concluded that the boulders had been carried the 100-metre length of the ravine by a strong flow of water, and dropped where the current lost its force.

"Any drainage down this [ravine]," continued Liberty, "must have come from the swamp areas ... at a time before the present drainage became effective." The flow indicated by the deposits was from east to west; whereas the modern swamp seepage was in the other direction. The swamps would have to rise more than half a metre just to start trickling down the now-dry ravine -- and examination of the bedrock shelf where they seeped down the hillside provided no evidence that it had ever been dammed at that end. Lee (1957) further pointed out that the total hilltop watershed of the three swamps (about 0.2 ha) was much too small to account for the heavy rush of water indicated by the boulders: "the only possible source would be from ice."

"We have to conjecture that the whole valley to the north was buried under ice," said Lee (Letter to F. Knechtel, 24 July 1954). "A heavy flow of water once rushed through that dry bed, sufficient to carry massive blocks of shale, quartzite and other rocks out to the west brow of the hill" (see Figure 2.2).

Ernst Antevs, when he was brought into the picture, however, kept in mind that the hill would have been submerged 100 m deep at the time of deglaciation. The ravine and high-energy flow deposits are "not explained by the mere presence of ice, but postulates a tunnel in solid ice, which must have covered the entire vicinity ... a subglacial chute ... formed by melt water running under strong hydrostatic pressure beneath the ice" (Letter: E. Antevs to T.E. Lee, 9 Feb. 1955).

Lee had arrived at Sheguiandah on the 14th of June, and left on the 7th of October, a period of 116 days. After the crew left at the end of the summer, he and Kenyon continued excavations through the month of September, with occasional assistance from Kennedy and Wright. Discoveries on the site had multiplied over the summer. "We cannot hope to get the answers this year," Lee had said (Letter to K.E. Kidd, 8 July 1954). "We are only now beginning to get the feel of this material. We dig with some confidence, in contrast to the slow groping of the first two years."

The Fourth Sheguiandah Expedition: 1955

Through the winter of 1954-55, Lee held discussions with the geologists of the Geological Survey almost daily. His contact with Antevs developed into a detailed four-way correspondence involving the two of them, Sanford, and Liberty; especially pertinent letters were also shared with Chapman, Prest, and Terasmae.

For a long time, Antevs (Letter to T.E. Lee, 7 Jan. 1955) was of the opinion that what Sanford called till, "could not have been directly deposited by the ice." He asked if the till-like deposits could not have been formed instead as a result of the Indians' quarrying activities. Had wind-thrown trees uprooted the ground? Soil movement from higher ground, he thought, might be the most important factor. "These and other possibilities are the only reasonable explanations for the burial of the artifacts."

Lee (Letter to E. Antevs, 9 Feb. 1955) responded: "All of the factors you mention must have been operative." He had identified evidence of digging by the Indians, for quarrying and other purposes. Falling trees had left their tell-tale marks. The site was certainly subject to extreme winter frosts. Yet these factors could not be pushed too far without raising problems, he told Antevs.

"Nothing has been observed about the site to suggest that tree-falling etc. was any more prevalent here than on other Indian sites across the country ... where no such mixing has been observed." Lee pointed out that the lower half of the till-like deposits contained lenses of fine sand or gravel: "would not frost heave upset such lenses?" Furthermore, "in spite of churning and mixing, by whatever causes, there is still a sort of stratigraphy preserved, in that the artifacts from the various deposits are typologically different, as well as varying in quantity from level to level. Where they are mixed together, the older materials have been brought to the surface, but the younger seem not to have been dropped appreciably."

Antevs knew that both Lee and Sanford contended that soil could not have flowed down from the higher ground to the north, because sharp ridges of quartzite lay squarely across the path of such movement. Liberty (Letter to Antevs, 28 Feb. 1955) supported them in this regard, saying: "I do not believe solifluction has played a major role at Sheguiandah. I won't say it has not been effective, but I see little evidence of it."

Antevs (Letter to T.E. Lee, 2 Feb. 1955) asked: "Could not the till have come from the sides of the ridges?" Lee (Letter to E. Antevs, 9 Feb. 1955) responded: "The ridges of quartzite are too small to have produced more than a fraction of the till-like deposits. Any movement of material in the troughs would have carried such material eastward and beyond most of the area in which we have been digging. This caused Chapman and other geologists visiting the site to reject solifluction in this form."

Antevs (Letter to T.E. Lee, 19 Feb. 1955) wrote back: "With the additional data [from you and Sanford] taken into consideration, I will start all over again." He painstakingly outlined the alternative theories for the deposition of artifacts, and then knocked them down with the evidence that had been supplied to him. With a clean drawing board in front of him, Antevs observed that "several of your geological associates have in the end reluctantly been forced to conclude that the gravel and till beds containing the artifacts were directly deposited by the ice. Now I share this view."

And then he set the stage for an important step further. "Some of your colleagues assume that man lived right at the edge of the ice during a return of the ice border, and that the artifacts somehow became incorporated as the beds were deposited. Objection: the Sheguiandah Site was surely under water when (first) released from the last ice sheet. Coexistence [of man and ice at the site] is to me disproved by our knowledge."

"I assume," he continued, "that the artifacts antedate the last ice sheet in the Great Lakes region ... and that they were picked up, transported, and deposited by the ice sheet many thousand years after man made them." Looking to the next warm interval back in the Wisconsin glaciation, he proposed that "the artifacts in the glacial till and gravel at Sheguiandah would be at least some 30,000 years old. Is an age of 30,000 years fantastic and alarming? I do not think so."

Lee (Letter to C. Compton, 5 Dec. 1959), however, was indeed startled -- so much so that he flew to Arizona to meet Antevs, "armed with ... colour slides, detailed graphs, photos. Antevs and the staff of [the research center called] Gila Pueblo went over this evidence with the utmost care." Lee (Letter to G.F. Carter, 6 Apr. 1955) returned home saying, "I went to Arizona ... expecting him to reverse his decision. Instead, he felt that the evidence strengthened it." "If this is substantiated," he realized, "Canada has by far the oldest known traces of man in the Americas" (Letter to H.S. Clarke, 29 May 1955).

Antevs was by no means finished with the issue, though. "He feels that we should put in one more year," said Lee (Letter to G.F. Carter, 6 Apr. 1955), "checking the specific points he has raised, ruling out other possibilities one by one." "How common are frost-shattered stones?" Antevs asked (Letter to T.E. Lee, 31 Mar. 1955). "How far have the pieces moved?" If soil with such evidence could be found, "note its difference from the till-like materials. [Determine] the rough quantitative proportions of till that can have been removed by creep, viscous flow, and wash from knolls and ridges and ... troughs to evaluate possible burial by such debris movements." Antevs also counselled a wider search for signs of "a big readvance of the ice border ... after Sheguiandah became dry land," and failing that, "examine the ... country N and NE of Sheguiandah for possible evidence of local glaciers after the departure of the ice sheet". He continued to question and challenge Lee for more than a year afterward.

Goals and Methods

The thrust of the 1955 work at Sheguiandah was directed toward "obtaining positive evidence of the antiquity of the site and a better understanding of the geology of the area" (Lee 1955c). Seventeen new trenches were opened on the hill, many for geological purposes, at the specific request of Bruce Liberty. Some cut across the Mystic Ridge ("to settle the disputes about its origin" -- Letter T.E. Lee to E. Antevs, 14 July 1955); others were placed at successive vertical intervals below the Nipissing notch. In two spots, a swampy area on the former Nipissing foreshore was dug. The outlet connecting the hilltop swamps with the dry ravine, which Antevs had called a subglacial chute, was trenched. Small test pits were made at various places over the hill and environs.

Additionally, eight of the old trenches were reopened: three in the swamps; the Hillside Dump; the 2-m deep pit in St. 7-8; St. 8-A; and St. 7-9, to show the boulder concentration. Lee wanted visiting geologists, archaeologists and palynologists to see as much of the evidence as possible. In their expert company, he traced out ancient beach lines for miles around. Together they examined beach and till deposits in the Sheguiandah area.

Jack Hough of the University of Illinois, for instance, came and spent two weeks in camp. Day after day Lee drove him as much as 60 km away so that he could trace out his interests -- the ancient beach lines of Manitoulin Island. Within a few years, Hough would publish a major work -- *The Geology of the Great Lakes*. But only briefly did he actually look at the Sheguiandah Site trenches, and then he disputed the idea that the till-like deposits had a glacial origin. To settle certain questions about the source of these sediments, Lee undertook to make a contour map of the Habitation Area in 1-foot (30-cm) intervals. He used a plane table and alidade, with stadia rods and a 100-ft (30-m) tape measure.

As for the swamps themselves, Jaan Terasmae had become interested enough to come and take his own samples. From the thickest organic deposits, in Swamp 3, he removed intact a 1.5-metre column of peat for pollen studies. Lee removed a 30-cm block for paleo-botanical studies by specialists in Ottawa, and collected a sample of the basal peat for submission to the United States Geological Survey in Washington, for radiocarbon analysis (Lee 1955c).

In the Habitation Area, two new 10-foot [3-m] squares were opened. St. 7-11, next to the Mystic Ridge, was dug to 90 cm. St. 7-12, out in the middle of the level land, was laid out for orientation studies. Digging here reached a depth of 100 cm.

Four small trenches, each 5 feet [1.5 m] square, were opened around the periphery of the Habitation Area: St. 6-A some 35 m to the west (dug to a maximum of 74 cm); St. 6-B and 7-A to the north (to 150 and 83 cm); and St. 8-B, 15 m to the east (to a depth of 110 cm).

In addition to the usual purposes and methods, Lee added new layers of investigation. All flakes and cores, normally discarded after examination, would first be counted. And "EVERY flake went on graph paper, half-inch depths" (Letter, T.E. Lee to D. Josselyn, 22 June 1963).

Some archaeologists considered the Sheguiandah cores, though large, to have been exhausted of their potential to produce flakes, so Lee (Letter to D. Josselyn, 22 June 1963) sacrificed 15 of them: "I used a hammerstone and reduced every core ... flake by flake, took notes on shapes and sizes".

One day during the summer, Lee (1976b) was talking with Terasmae, who was then visiting the site. "Terasmae," he recalled, "is often called a palynologist by my opponents ... to indicate that he was not a glacial geologist. Quite the contrary. [He] was trained in Estonia, in glacial geology. And he knew glacial geology better than some of the others ... we were sitting on the edge of a trench. I said, 'If this is glacial till, there should be some way to prove it ... how would you identify glacial till?' He said, 'Well, the pebbles should have glacial striae on them for one thing, and facets.' And I reached down and picked up a pebble, and said, 'Like this?' He said, 'Yes, exactly like that.' He said, 'This is glacial till.'"

And so Lee began to study the natural stones, or clasts, as well as those modified by man. In several of the Habitation Area trenches, and particularly in St. 7-12, all stones were set aside and sorted according to material. Each was examined for glacial facets and striae. Then, deposit by deposit, the number of stones of each type were counted. Finally, both they and the remaining fine material were measured as to aggregate volumes (boulders were measured individually). Lee was searching for lithic differences that would further distinguish the two layers of till.

Similar questions about the identification of till, put to Prest and Liberty, led to another line of investigation. As stones were exposed by excavation, nearly 600 of them were measured for bearing and dip. The objective was to see if elongated clasts in the tills had taken on, and retained, an orientation in response to stresses resulting from glacial ice flow. Such a tendency to orientation in a sediment is called a fabric.

Working on a horizontal surface, Lee used a Brunton compass with an inclinometer to take two measurements on each stone's orientation, in situ. He further recorded the direction of the long-axis dip as a double-check. As each clast was removed from the sediments, it was measured for length, width and thickness, and described as to mineralogy and degree of rounding. Control observations were obtained by making these measurements not only in sediments thought to be glacial till, but in every deposit from the surface down, and by taking bearings regardless of clast geometry, as long as a definite long axis was apparent.

As if anticipating the complex experimental design laid out by Andrews (1971), Lee sampled from multiple locations and depths, and made the measurements necessary for an evaluation of the effects of stone morphometry in the fabrics. But that very breadth of investigation also works against us, in that the impressive overall sample is subdivided among deposits, trenches, and stone shapes to the point where many times, too few clasts are available for statistical validity within a given sample.

Fabrics can be presented visually by various plotting methods, and their strength measured by means of the clustering of individual orientations around an axis. Lee laboriously made a plot of the data from one level, by hand, on polar graph paper. Using a computer program (Stereonet: Allmendinger 1988), I have now obtained three-dimensional plots based on Kamb's (1959) method from all his data, along with the associated eigenvectors that measure the strength of orientation.

Field and Laboratory Results, with Interpretations

Lee spent 122 days at Sheguiandah in 1955, arriving on the 19th of June, and not leaving until the 18th of October. The artifacts recovered in the Habitation Area digging generally followed the established pattern. Several projectile points and drills were found.

In St. 7-11, the humus layer yielded 50 bifaces, 464 cores, and 21,703 quartzite flakes. With a hammer, Lee reduced fifteen of the cores to about 25 flakes each, thereby showing that they were not exhausted, but had been discarded by the Indians for other reasons. Over most of the square, the till-like deposit was quite shallow because of bedrock. Parts of the quartzite exposed by excavation were glacially smoothed and striated, while others were broken in the manner of glacial plucking. Some portions showed signs of quarrying (Lee 1957).

In St. 7-12, "a fluted Paleoindian projectile point" was found at the transitional level (Lee 1955c). Just below that, at the boundary with the till-like deposits, a pattern of 35 post moulds appeared, "which show the presence of one or more dwellings."

The till-like deposits themselves yielded biface fragments, cores, used flakes, and a fire-cracked piece of quartzite at depths of up to 57 cm.

In the clays below, at depths of 70 and 95 cm, three flakes were found, and two cores, one of them worked.

The four 5-foot squares showed distributions of sediments and archaeological material in keeping with the general picture already developed. Variations, such as a concentration of boulders in the till-like layers (St. 7-A), or a "remarkable scarcity" of them (St. 6-A), were too isolated and too limited in exposure to permit Lee to draw conclusions. It was perhaps difficult to make stratigraphic correlations with certainty across distances of 50 metres.

Archaeologically, St. 6-A was "important for yielding a definite biface tool and man-made chips in lake clays below the till layer" (Lee 1955c). St. 6-B exposed part of a prehistoric pit. This pit was notable for producing the only animal material in four years of digging on the site: several fish bones, apparently preserved in charcoal. Very fine flakes, "the size of fish scales," as well as signs of fire, were found within the pit's fill (Lee: Field Note Summaries, 1955).

In St. 7-A, at a depth of 7.5 cm, "in humus, but on transitional" soil, a chert projectile point was found. Very little turned up in the till-like deposits: a core and chips at 30-35 cm depth, a hammerstone at 40 cm, and a few quartzite chips at depths of up to 57 cm. But the possibility of limited disturbance was noted at various depths, in the form of large tree roots and also "holes and/or soft spots" that were believed to be either the spaces formerly occupied by roots, since decayed away, or rodent holes.

St. 8-B turned out to be one of the most interesting trenches on the site, because it exposed a laminated silty deposit in its lower half, under the till-like layers. "It proves," said Lee (1955c) "that certain deposits at depth in the Habitation Area, long disputed, were correctly identified by Sanford only" as lake deposits.

If, as expected, the archaeological materials produced no surprises, several valuable findings did emerge from the sedimentological studies. The till-like deposits were shown to contain many stones, such as granite and greenstone, and varieties of quartzite unlike those that form the hill -- all of which were foreign to the site, and must have been brought there by ice. Many were glacially faceted, and 242 stones, which make up only a small proportion (1% to 2% by volume) of the total, bore glacial striae.

Other stones, however, notably shale and certain distinctive quartzites were of very local origin. The shale was especially significant for suggesting how artifacts might have persisted through a glacial action. This rock crops out downhill from the Habitation Area to the east and northeast, and, so Lee reasoned, must also have been brought upslope by ice. But it is so soft that it can be carved with a knife, and would not have survived long in a glacier; it spoke for movement over only a very little distance.

Fine material (up to and including small pebbles) made up 70% to 80% of the till-like deposits in St. 7-12, as measured by volume. Two samples previously taken from the till-like deposits in St. 7-2 had yielded a distribution of grain sizes that Sanford (in Lee 1979) explained as showing the unsorted nature of these materials. Seven more of Lee's samples of the matrix of the till-like deposits, from Stations 7-1, 7-2, 7-3, 7-4, and 7-8, have also been analyzed, and confirm that "they are not sorted" (Julig *et al.* 1994).

The coarse fraction of the St. 7-12 materials (20 to 30% of the till-like deposits) were made up almost entirely of stones shaped by natural forces. Of the approximately 10,000 clasts in the till-like deposits, about 50% (by volume) were entirely foreign to the site, being igneous or metamorphic (principally granite and greenstone), 22% shale, 17% local quartzite, 3% quartzite from the Mystic Ridge, and 2% foreign quartzite. The average length was 10 cm, with a range from about 2.5 to 50 cm. The average fragment of shale, at about 5 cm, was much smaller that the other rock types, though blocks of shale up to 30 cm in diameter were occasionally found.

Lee (Field Note Summaries, 1955) focused attention on the character and condition of the shale in each level, with results that revealed something about the effectiveness of frost in these soils. Shale fragments from the humus and transitional levels (down to about 17 cm) were "shattered, flaky, few rounded." In the top 5 cm of the till-like deposits the shale was described as "chunkier, mainly sub-angular, some rounded fewer flakes or slabs." Below 27 cm depth, throughout the rest of the till-like deposits and into the clays below them, there was "much less" to "very little shattering," the blocky pieces ("not slabs") being mainly sub-angular.

Though there was no sign of frost-shattering within the body of the till-like deposits to account for size differences, both the mean and the maximum sizes of shale clasts were noticeably greater in the lower part, where the largest of them reached the size of small boulders. This Lee took as further evidence in support of the till-like deposits being in two layers.

A sample of 575 clasts was the final subject of Lee's orientation studies. Of those in the till-like deposits, about 75% were described as igneous, 15% local quartzite, and 5% shale. Shale may be under-represented in the fabric study because so much of it was in fragments too small for the purpose. Elongated stones made up about two-thirds of this sample (rods 32% and blades 29%); tabulate clasts made up 27%, and equant stones 11%. About 35% of the clasts were judged angular, 36% subangular, and 29% rounded. The average length was 15 cm, with a range from just under 4 cm to just over 50 cm.

After plotting the data from one of the till-like deposits, Lee (1955c, 1979) reported that "the probable direction of movement is now known" as being from the northeast. This, he pointed out, was consistent with the direction of ice flow at Sheguiandah. Such a pattern is evident in a three-dimensional plot recently obtained by computer for the lower till-like deposit (Figure 2.13). But a fabric diagram for the upper till-like deposit reveals an orientation at right-angles to the lower. The indurated clay identified as a till by Barnett (1992), beneath the controversial "till-like" deposits (discussed here), also has a transverse orientation (see Barnett, this volume).

The orientations range from weak (S_1 values of .43) to moderately strong (S_1 values of .66) (note Figure 2.13 below). Fabric diagrams like these are well known from glacial tills, where the dominant alignment may lie in line with ice flow, or transversely to it, depending on the sum of forces in the glacier (Pettijohn 1975).

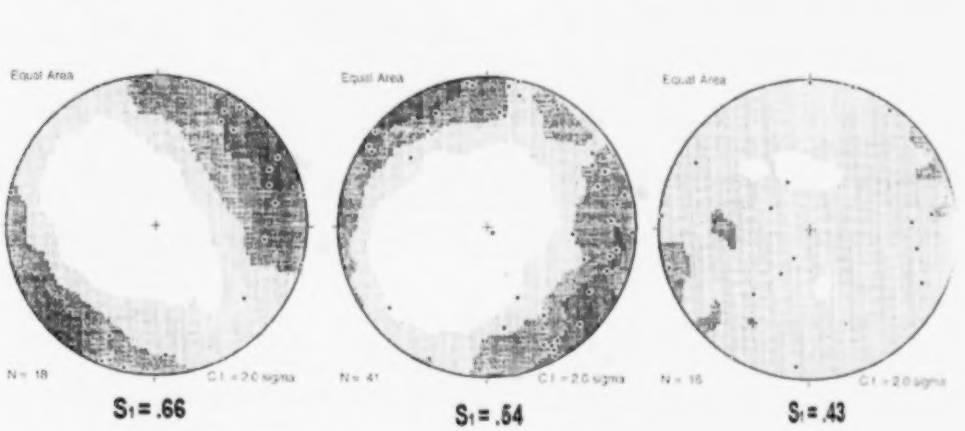


Figure 2.13. Contour diagrams of fabrics with scatter plots of individual clasts superimposed, based on elongate stones (a:b>1.8; b:c < 2) from the controversial till-like deposits in St. 7-12. Each plot represents the circle of the compass with a three-dimensional aspect: stones dipping to the east would appear at the right, to the west at the left, and standing almost vertically, in the center.

Stones in the lower till-like deposit (a) have preferred orientations aligned with the regional direction of glacial ice flow; those in the body of the upper deposit (b) have a transverse orientation. In the topmost 5 cm of the upper till-like deposit (c) there is no preferred orientation.

By contrast, in the humus and transitional levels, and in the topmost 5 cm of the till-like deposits, fabric diagrams show very weak or random orientation of clasts (Figure 2.13). In these cases the principal eigenvector, S_1, ranges from .41 to .50. Either these deposits never had any preferred orientation, or else the fabric has been completely disrupted.

The Mystic Ridge is a low landscape feature that curves around the south and east sides of the hill (see Figure 2.2). It bounds the Habitation Area on the south. Lee (1955c) believed that observations made on it were "of the utmost importance to our investigations" regarding sediment origins in the Habitation Area. The ridge had long defied conclusive explanation. "One geologist said it was a storm beach, another geologist said it was an ice pressure ridge, another geologist said it was a man-made ridge [and] an archaeologist said it was not a man-made ridge" (Letter: T.E. Lee to J.T. Sanford, 1 Oct. 1952). Liberty (Letter to E. Antevs, 28 Feb. 1955) said, "it looks like a beach -- and always has -- to me." Lee thought he had settled the issue in 1952, showing then that the stones seen on the surface were weathering out of a dolomite-quartzite conglomerate. But dispute continued, and in 1955 three trenches were cut in it. The longest (9 m) was dug to bedrock over its entire length, from one side of the ridge to the other.

This section (Figure 2.14) amplified the previous findings. Firstly, except for the "thin veneer of chips, artifacts, and quarry debris over it," (Lee, Field Journal, 20 Aug. 1952), the loose sediments of the Mystic Ridge bore nothing even attributable to man below 20 cm (Letter: T.E. Lee to E. Antevs, 14 July 1955).

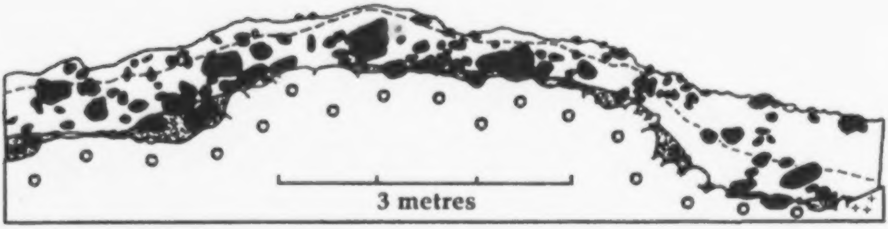


Figure 2.14. Profile of a trench dug across the Mystic Ridge to bedrock (conglomerate, as indicated by small circles, resting on quartzite at extreme right). Notable features are the unusual softness of the ridge's bedrock core, which in places was inadvertently excavated by hand tools (shown by shading); and the limited depth of cultural material over the ridge (dashed line), as compared with its occurrence in the immediately adjacent Habitation Area at right.

Secondly, the loose sediment on the crest, to a depth of 75 cm, contained no foreign stones. Only quartzite cobbles and boulders were present; these were well rounded and showed signs of heavy battering.

Thirdly, the Mystic Ridge had a bedrock core of conglomerate, in which quartzite boulders were set in dolomite. But that bedrock was so soft that the man digging the trench actually excavated a boulder from the dolomite without realizing it. By this time, Sanford knew that, in comparison, nearby exposures of this conglomerate in the area were much harder. The picture was one of a bedrock feature disintegrating in place; the weathering of the dolomite was so extreme that "it must have been accomplished in preglacial time" (Sanford 1957).

The implications were several. Chief among them was that unconsolidated sediments on the site had survived the glaciation intact, protected from glacial erosion by their position on the lee side of the hill itself. This meant that the Habitation Area, lying even more closely against the flank of the hilltop, had also been protected. Soft sediments there, such as the "lake clays" under the till-like deposits, need not be from post-glacial Lake Algonquin, as had been assumed up until now (Lee 1954c), but "might very well have been formed in a proglacial lake" (Sanford 1957). This represented a key shift in Sanford's thinking, because he no longer felt he had to explain the till-like deposits themselves as having been left by a post-Lake-Algonquin readvance of the ice. He and Antevs were already agreed that these deposits were glacial till; now they could also agree on a Wisconsin genesis for them.

Visiting geologist Jack Hough, however, contended that the till-like sediments were mudflow, rather than true till (Letter: T.E. Lee to G.F. Carter, 11 Aug. 1955). Arguing the matter on the spot, Lee pointed out that the porous nature of the materials had caused Chapman and others to reject this explanation: they wouldn't hold water. Hough changed his term to "mass movement."

From where could the sediments have come? Looking around for a source, Hough pointed to the rising ground in the north. Walking over to it with him, Lee showed Hough that several sharp, east-west ridges of quartzite lay across that route. Hough conceded that these ridges form a barrier now, but proposed that the troughs between them had formerly been filled up, so that the "mud" could simply flow over the top of them. Lee demanded to know where that filler material had gone; it was nowhere to be seen.

Hough's last argument was that the mass of material had flowed eastward between the ridges, angling across the slope and reaching its foot at the very eastern edge of the Habitation Area; there, he contended, it had doubled back and spread out. Lee told him there was no slope within the Habitation Area to support such a doubling back; Hough said there was "plenty of slope." With the critical terrain cloaked in undergrowth, there the argument hung. Hough left the site, and was heard from only once more, in the autumn.

In the meantime, Lee set out to determine the degree of slope in question by making a detailed contour map (Figure 2.15). It revealed that the Habitation Area surface was quite flat and almost level. At the point where Hough would have had his mass movement come down, the ground actually fell away to the east, meaning that the material would have had to turn away from the pull of gravity to settle in the Habitation Area.

Turning to the trench across the neck of the hilltop ravine, which connected the swamps to the onetime outfall of what Antevs considered a subglacial chute, Lee found a water-sorted deposit of dense sandy silt more than a metre deep (Letter: T.E. Lee to E. Antevs, 14 July 1955). The other geologically-oriented trenches on various parts of the site apparently provided little information capable of contributing to the interpretations being developed, for they receive scant mention anywhere in the record.

After the season was ended, however, the swamps provided two lines of evidence establishing a minimum age for the site. First, Terasmae's analysis of the pollen samples from Swamp 3 showed a pattern consistent with the vegetational changes known throughout post-glacial time. Second, the bottom inch of peat was radiocarbon dated to 9130+/-250 years by the U.S. Geological Survey (Lee 1956). Elated, Lee went to his Director, Alcock, with the news that the Museum now had the oldest dated evidence of man in eastern North America. Alcock, to Lee's amazement, received the news with anger. "Angry instead of delighted. What does it mean?" Lee asked (Letter to A.K. Guthe, 1 Feb. 1956).

Unknown to Lee, Alcock had asked for, and received, a brief report from Hough (Letter to F.J. Alcock, 26 Oct. 1955), who made an exaggerated claim to have "examined the site rather thoroughly [for] nearly two weeks this past summer."

While acknowledging (as he had not to Lee) that "artifacts occur within a material which looks like till," and that "a sample of the material would be identified as till by almost any geologist it was shown to," he told Alcock: "I believe ... that the artifacts accumulated on the surface of a till deposit, and that slow downhill creep [mixed] the artifact[s] into the till ... the topography and distribution of materials permit the mass movement interpretation."

"I cannot prove that this interpretation is the correct one," Hough continued. "It remains only a possibility." Nevertheless, he concluded: "My own tentative view of the age of the early material at the site is that it is post-last glacial advance ... and later than the highest or main Algonquin Lake stage. It could be as late as Nipissing."

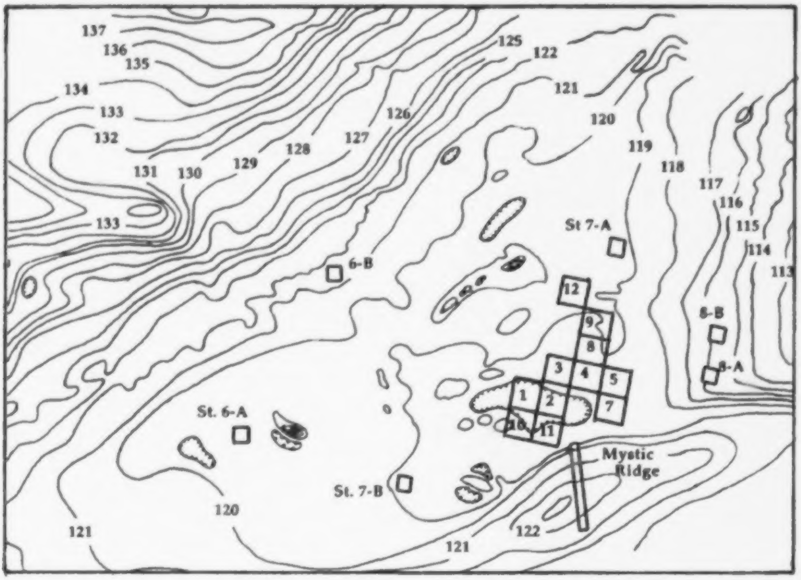


Figure 2.15. Portion of Lee's contour map of the Habitation Area, in 1-ft contour intervals (elevations above Lake Huron). Scale is indicated by the cluster of square trenches at right, which are each 10 ft (3 m) across. Apart from a small ridge just left of St. 7-12 (bedrock) and pit-and-mound feature to the right of St. 6-A (old tree-fall), the terrain is relatively even and level. It had been argued that mudflow or mass movement brought the controversial deposits into the Habitation Area from the upper right corner. (North is to the top of figure).

With this opinion in hand, Alcock ordered Lee never to dig at Sheguiandah again. As Lee contemplated the 1956 field season, he (Letter: 24 Feb. 1956) wrote to tell Antevs: "I am to dig some ceramic site this year -- we do not even know where or which one -- or why."

A quarter century later a journalist would write: "It is Lee's dream to dig again at Sheguiandah, with a team of top North American archaeologists and geologists looking on" (Doig 1979). But it never happened. In 1955 Lee had backfilled his trenches there for the last time. Such had been his practice every year, so as to avoid inadvertently encouraging casual looting. For the future, however, he marked the outlines of the squares with lines of cobbles, which can still be seen today.

One Last Look

In 1957, Lee's survey again took him to Manitoulin, and over a period of three weeks he looked in at the Sheguiandah Site, reviewed the scene with Terasmae, and excavated at a cave on the neighbouring hill.

The Blasted Cave Site

The hill immediately to the north may well have been another Sheguiandah, for the big bifaces were found for 600 metres all along the slope facing the site, and aboriginal quarrying was extensive above the cave opening. But modern industrial quarrying for silica had almost totally demolished the hill, leaving a thin shell of rock around the edge. The cave was in the line of the quarry's final expansion, and would probably not exist for much longer. After 20 years of nearby blasting, its roof was shattered, and heavy blocks of stone had fallen since Lee's first examination in 1954.

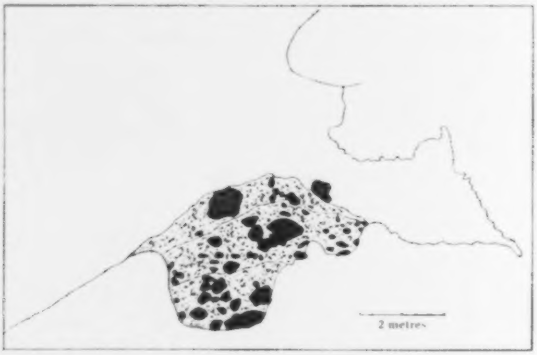


Figure 2.16. Profile of the Blasted Cave site, showing two buried layers of humus in 3.3 m-deep excavation down toward the debris-covered floor, under the lip of the conglomerate overhang. It is believed to no longer exist.

Lee found it just within his means to excavate with the help of two experienced OAS members, Bill Renison and Ruth Marshall. After establishing a datum line, Lee (Field Notes, August 1957) laid out a trench 2.4 metres wide, "since it will obviously be deep and dangerous," and 5 metres long, from well outside the lip of the cave's entrance, up over the mound of debris that nearly closed it off, and into the cramped interior. In a race against time, he worked with a mattock, and at times a sledgehammer. He attempted to strip away the rubble in layers, but working through boulders, found "close control impossible."

The cave had been cut, at least in part, by wave action eroding a thick layer of relatively soft conglomerate or breccia, as was shown by a blow hole in the roof (Figure 2.16). Cores and flakes made by splitting the quartzite cobbles from this breccia showed that man had been in the cave to get them; other quartzite artifacts could conceivably have come from the Indian quarrying above. These man-made materials began to appear within 20 cm of the surface, at which depth the blocky cave-fall debris became much sandier and darkly reddish. Here the soil could be stripped in levels.

The trench walls were now packed with precariously hanging boulders. At a depth of 1.35 metres, a concentration of charcoal was found up against two converging boulders, which would have acted as a natural chimney. At the same level, outside the lip of the cave, a buried humus line appeared. Charcoal samples were collected in aluminium foil for radiocarbon dating.

At 2.1 metres depth, a second humus line appeared. Lee took a soil sample. Below this, the sand was yellowish, rather than red, and contrasted strikingly with the humus-laden layer lying upon it.

At 3.3 metres depth, Lee encountered a "deep soil which is very dark, fine, dusty," in which he believed he would find the evidence of the cave's first occupants. But it was the last day, and the last hour, allotted to his investigation. Alcock would not authorize any extension. "Unable to complete even one level into soil of cave. Scattering a few pieces of rubble over it in the hope that we will get back another year."

Lee lost his job with the Museum 18 months later, and never returned to the cave. It is believed that the quarry operation subsequently destroyed it.

But as caves and rock shelters are scarce in Ontario, it is perhaps of some value that Lee devoted much of his precious excavation time to profiling the trench walls and investigating the nature of the cave. Thus we know that it was at least 10 metres wide, 4 metres deep, and from the deepest soil exposed to lowest part of the irregular, arched roof, 4 metres high. "The position of this feature," Lee concluded in his field notes, "above the Nipissing notch and in sight of the Sheguiandah site, makes it hard to believe that Indians neglected it entirely."

Salvage Operations at the Sheguiandah Site

While engaged in hurried digging at the Blasted Cave, Lee discovered that looters had ripped into the Sheguiandah Site's Habitation Area. Lee put his two assistants onto the spot, laying out a new 10-foot square, St. 7-13, to take in the damage, and had them rapidly strip away the soil down to the top of the till-like deposits. Almost one-quarter of this square had been torn apart. A number of artifacts, including a projectile point, were salvaged. The square was backfilled to look as natural as possible.

Searching quickly over the hill, Lee (Letter to B. Cathcart, 16 Dec. 1957) observed signs of looting in 44 places, which had an aggregate area of almost 20 square metres. The Habitation Area was the hardest hit, but digging was also evident on the Hillside Dump, in Swamp Area 1, the Middle Quarry Ridge, and the Upper Quarry Ridge. Some of the pits were 20 to 30 cm deep. Most of the damage was only shallow scraping, but even that must have been rewarding for there to be so much of it. Lee immediately reported the situation to the OPP and the Minister responsible for protected sites, and stationed one of his crew members on the site to guard it for the last two weeks of the season.

The Sheguiandah Site's only protection since then has been the neglect that fosters the growth of weeds and forgetfulness. And the collectors have never forgotten. Each summer, unauthorized and secretive digging goes on. In the Habitation Area, significant areas look as if a rototiller had been run through the woods (personal communication, Jamie Linton, 2000).

Reaching out to the Profession: Contacts and Publications

It will be apparent that, at one time, a great many people either possessed some degree of first-hand knowledge of the Sheguiandah Site, or were acquainted with it through personal contact with Lee himself. Considering that Lee continued to lecture and publish on the site all his life, it is a remarkable thing that Sheguiandah should one day be described as "Canada's most neglected major site of the past 30 years" (Jackson and McKillop 1987). For the archaeologist or geologist now trying to come to grips with the site, as well as for the student of scientific history, it is important to understand the nature of the available information, and the constraints upon it.

The site was surely well known in the archaeological community of the 1950s. The correspondence record attests to that. As well, more than 80 people worked in Lee's crews, including such prominent OAS enthusiasts as Clyde Kennedy, Ruth Marshall, and Glenna Woolley, and a number of archaeology students who later became well known in the profession: Ken Dawson, Walter Kenyon, Bill Taylor, and Jim Wright.

As soon as the potential of the site had become apparent to him, in his first season there, Lee (Letter to F. J. Alcock, 21 Aug. 1952) moved swiftly to have his director invite a number of scientists to the site, starting with Ernst Antevs and prominent figures from the Bureau of American Ethnology. "The find," he believed, "is certainly great enough to attract the attention of every learned man in America ... I would like to have the opinions of yourself and the various archaeologists and geologists to whom this letter is being sent." Ultimately, more than a hundred came to the site.

Sanford was among the first. "He wasn't a glacial geologist," said Lee (1976b), "but he knew glacial geology, just as most geologists do." He described himself as a stratigrapher. "I saw Sanford come back again and again," Lee said, "year after year, sampling, testing, questioning." Later, Antevs was to "pour forth what must be described as a monumental effort -- amazing to all who have seen the correspondence. True," said Lee (Letter to A.H. Schroeder, 24 Jan. 1956), "he has not seen the site, but he has worked in the area". And Liberty, he told Antevs (Letter: 14 July 1955) "is slow, cautious, careful in everything that he does." In Liberty's second year, 1955, he had come to the site "every day, and sometimes twice a day, with his crew, all summer long, for two months [and] examined everything that there was to be seen ... he discussed every detail of it with me" (Lee 1976b).

Lee also took his evidence to those he considered authorities, travelling twice to Globe, Arizona to consult with Antevs, to Denver to outline his findings for H. Marie Wormington, who was working on the fourth edition of her handbook, *Ancient Man in America* (1957), and to Detroit, where he, Sanford and Greenman thrashed out the issues before an extended session of the 1954 American Anthropological Association meeting, chaired by James B. Griffin. He corresponded extensively, sending out a flood of queries and sketches, and distributed collections to individuals and institutions all over North America and into Europe. The Royal Ontario Museum in particular received the most representative collection he could put together.

As is sometimes pointed out, there never was a final report. Lee himself was acutely aware of this problem. "Sheguiandah," he ruefully declared, "was never adequately published" (Lee

1974a). But he was also indignant. "That is not to say, as some have attempted to do, that it was never published at all [see Lee 1963b]. Indeed," he declared, "there are approximately 20 papers about it, by myself or the geologist John Sanford" (Lee 1974a).

Nonetheless, from an early stage Lee (Letter to E. Antevs, 30 Jan. 1956) "looked in vain for any mention of Sheguiandah in lists of Early Man publications. It has been carefully avoided." And although Sheguiandah was primarily an archaeological site, archaeologists seemed to shy away from it. "It drew about 100 geologists to it," said Lee (1964b), "some of them again and again, who found their beliefs and training challenged by it. It drew perhaps a half-dozen archaeologists for a quick look, during four years of well-publicized excavating."

"Why do not the archaeologists come and have a look?" Lee asked. "I know that some of them have passed within 40 miles of it, while the work was in progress" (Letter: T.E.Lee to G.F. Carter, 2 Feb. 1956).

As for Lee going to them -- in Arizona and Colorado, for instance -- this was done entirely at his own expense. Year after year in the Museum, Alcock told him that there was only enough travel money to send R.S. "Scotty" MacNeish, who would "represent" him (Letter: T.E. Lee to A.D. Krieger, 17 Dec. 1961). "MacNeish," Lee said (Letter to D.F. Jordan, 22 Nov. 1959) "once spent 10 minutes going through the Sheg collections -- all of them -- in order to speak as an authority." As Lee (1954d) saw for himself, this did not seem to result in a favourable appreciation of the site among his colleagues.

The site had started under a cloud of misinformation as a "Point Peninsula workshop." Sheguiandah, so overwhelmingly quartzite, subsequently came to be portrayed as a "flint industry" (Martin 1958), characterized by "large notched" projectile points (Wormington 1957). Griffin (1979) eventually defined it out of existence, labelling it a "nonsite."

"The doubt about Sheg ... is known to almost every professional and student across America," Lee told F. Ridley (Letter: 6 May 1966). "The bible in this business is Wormington -- and she destroyed the site in a couple of paragraphs -- all that most will ever read." From Compton (Letter: 19 Oct. 1959), Lee learned that "Wormington ... is convinced you are 'way out there' and that this business is a figurement of your imagination. She is convinced because Scotty told her so; I was present at the time."

But there never should have been such reliance on secondary sources, given the number of promptly produced papers on the subject by Lee and Sanford. Lee (1953) had begun with an account of the discovery itself. "I feel very strongly," he said, "about the desirability of getting out preliminary reports in order that others may use one's discoveries, consider the ideas expressed, and challenge. Further, one's ideas should be set down at the time ... who knows when the investigator may cease to exist ... or under pressure, shift to something else" (Letter: T.E.Lee to A.K. Guthe, 29 Jan. 1954).

Before he could get out his report on the first expedition, however, he was informed that the National Museum would no longer publish interim reports (Letter: T.E. Lee to A.K. Guthe, 29

Jan. 1954). Therefore, his first two expedition reports appeared in American Antiquity (Lee 1954b; 1955b).

Lee began publishing outside with some regret, because space limitations now prevented him from describing his methods as fully as he would have liked. "I'd need a book to describe actual procedures," he said (Letter to D. Josselyn, 22 June 1963). No such book was ever written, and so it is that this account relies so heavily on unpublished reports, field notes, and correspondence.

At the same time, Lee found the services of his own institution's photographic section being made unavailable to him. "Can you imagine a National Museum sending out 25-man expeditions to dig a site for four years," he asked (Letter to M.F. Farmer, 7 July 1981); "then telling the investigator, 'There is only enough money to publish Dr. MacNeish's photos -- you will have to do your reports without pictures.' It happened -- to me."

"As a result," he said, "only my line drawings have appeared. I selected what seemed most appropriate for any particular paper, usually the projectile points, a few of the cores, a biface or two. These are anything but representative. Sheguiandah artifacts are poorly known."

Publication delays gave him the opportunity to revise each expedition report in the light of subsequent findings, but he preferred to let his early ideas stand: "I have presented the case as I saw and understood it at the end of 1952 in one paper and at the end of 1953 in the other" (Letter: T.E. Lee to J.T. Sanford, 26 Mar. 1954).

Lee's report on the third expedition (Lee 1955a) was in progress when Alcock ordered him to end the work; it was never published. For some time Lee (Letter to R. Kenyon, 12 Aug. 1953) had been convinced that Greenman "and others like him have done incalculable harm ... to this wonderful site, by casting doubt on its antiquity in professional circles across the United States and Canada. Nothing short of a full-scale and detailed report, amply illustrated ... can correct the situation now." Lee immediately requested support for the preparation of a final report. But Alcock pointedly refused even secretarial help for that, which would surely have been a major undertaking (Letter: T.E. Lee to E. Antevs, 30 Jan. 1956).

In this same period, *American Antiquity*'s assistant editor for the northeast, A.K. Guthe, (Letter to T.E. Lee, 28 Sept. 1955) told Lee that a brief account of the Sheguiandah investigation he had prepared would not be suitable even as a news item because of "the controversial character of the site." Within months, his full report was also rejected by the same journal.

Lee (Letter to A.K. Guthe, 1 Feb. 1956) was dismayed: "I'm sitting on a treasure-house of information on early man," he said, "and there is grave doubt that it will ever be published, unless in ... piecemeal fashion."

American Antiquity did accept Lee's (1956) one-page account of the 9000-BP radiocarbon determination, perhaps because the editor did not realize that the discussion had to do with the position and meaning of the sample, rather than the date, and that it supported the much greater age proposed for the site.

Lee now divided an already lengthy manuscript into small sections, "in the hope that just a little of the evidence could appear in print" (Lee 1964b). Much was dropped from his discussion, although he knew that in so doing he would lose support. "I cannot help but be disturbed at being unable to present both sides of the argument," Lee said (Letter to F. Ridley, 15 Apr. 1956). "Antevs wanted that -- and I understand why. He feels any other course will expose me to criticism from the real scientists. In my revised paper I state that I do not think we are dealing with solifluction, frost action, tree plowing, etc. The real scientist will wonder why it cannot be -- and what my training and experience may be to justify any such conclusion. In my [long] paper ... I went into the details of the argument with this in mind. I wanted to demonstrate that I had covered the literature of the Pleistocene adequately."

One of these much reduced sections would become the principal report on the site, even though he had "stripped [it] of most of the results of the 1954 work [and was] not using '55 results, except to evaluate the previous findings" (Letter: T.E. Lee to E. Antevs, 30 Jan. 1956). "This," he told Antevs (Letter: 1 Feb. 1956), "is being reserved until I can work up the [clast] orientation and volume data."

For this major report, "no outlet was found until 1957," said Lee (1964b), "when *The Canadian Field Naturalist* under took to publish what for it was a new field of interest." "The Antiquity of the Sheguiandah Site," by Lee, and Sanford's "Geologic Observations at the Sheguiandah Site" appeared back-to-back in 1957. These papers dealt almost exclusively with the evidence and arguments for and against a proposed glacial age ("a minimum of 30,000 years").

Lee found himself criticized for reporting so little of the archaeology. "Proving the antiquity had to come first," Lee explained (Letter to G.F. Carter, 19 Jan. 1956) "since the work could be halted at any moment if its importance were not shown ... I'm sorry it is this way, but every step was taken in response to the pressure of criticism and opposition."

Even so, there was enough in "Antiquity of the Sheguiandah Site" to show how Lee liked to handle archaeological material in his reports. There, each of the projectile points was described separately in terms of lithic material, shape, and most especially, stone-working techniques. "I handled artifacts in large quantity from 1928 to 1952 before I began to understand anything about stone-working," Lee said (Letter to D. Josselyn, 6 Mar. 1965); "at Sheguiandah I suddenly came into masses of stone material that had to be handled and sorted each day -- by me." Lee (1964b) also experimented with the quartzite there. "Flaking has been my baby at Sheg," said Lee (Letter to D. Bell, 4 Jan. 1956); "flakes mean something to me."

In Lee's (1963a) report on the associated Point Peninsula site, we can see that knives, bifaces and even hammerstones also received individual treatment. But when he had the freedom of a full monograph, as in his Abitibi report (Lee 1965), almost every specimen of every kind was illustrated and discussed. "You don't just throw a bag of artifacts at us," said Josselyn (Letter: 14 Dec. 1965) in praise of this report; "you describe and draw them, so that each may tell its story ... you prefer to point [out] the problems and questions your artifacts pose, rather than giving false finalities. I wish to heaven you could give your Sheguiandah material this treatment."

It was with an eye to detail on this level that Lee examined his own Sheguiandah collections, and drew the generalized conclusions expressed in his more geologically oriented reports. Together with the perspective gained in his extensive survey experience, Lee's analysis of the material led him to question most deeply what at first seemed obvious: that the site was a quarry along the lines of the classic quarry model. This paper, too, ran into obstacles. Lee (1964b) eventually got it into print with an earlier editor's revealing deletions reinstated in bold face, "for the discerning reader."

After a dozen years had passed, Sanford (1971) felt that there had been sufficient progress in Pleistocene and post-glacial studies to warrant a re-evaluation of the site. After a thorough review of the evidence, he reiterated his convictions: "I have no doubt," he said, "as to the genesis of the two till layers." The improved understanding of the regional setting, however, now led him to conclude that "30,000 years ... appears to allow far too little time to permit the sequence of events."

Soon Lee (1974b), too, was asking, "How, then, does Sheguiandah fit into today's evidence?" Where he had felt very much alone at first, now he could point to an increasing number of comparably dated sites. As for Sheguiandah, "Sanford has spelled it out ... the site is interglacial. You may put your own age estimate on that." After a very frank discussion of what had happened to the site, his manuscripts, and himself, he declared: "the climate is rapidly changing. Men at last are daring to speak out about what they are finding in the ground. A more receptive and alert audience is available ... the great pity is that Sheguiandah was found 23 years too soon."

Ultimately, realizing that, as he had predicted long before, the results of his final year's work might never be published, Lee (1979) determined to touch on them with a few carefully chosen words in a brief synopsis of the site.

John T. Sanford died in 1981, and Thomas E. Lee a year later, just days after making a last trip to the hill above Sheguiandah Bay.

How Methods Made the Difference

It has been said that Lee's interpretations at Sheguiandah provoked controversy, "despite his rigorous techniques" (Cooper and Robertson 1992). A little thought about the standards of the day will suggest that it would be equally true to say controversy arose *because* of them. Lee himself could not have interpreted the site the same way if he had dug as his fellow archaeologists did. And although he was told many times that he was digging in glacial till, he could not have defended that position with untested geological opinion.

"I came out of university steeped in the six-inch level idea," Lee said (Letter to D. Josselyn, 22 June 1963). "Before one season was out, I was digging in 3-inch levels. By the second summer, I was digging in one-inch levels. Two summers later, at Sheg ... we tried one-inch. Impossible -- unless I wanted to lose the evidence. We tried 1/2 inch levels. Again impossible -- the material was fantastically thick, right to the surface. We instead followed the procedure of brushing, photographing, removing, over and over."

The degree of care and control he exercised brought high praise: Carpenter, who had seen the work at Sheguiandah, characterized it as "the most carefully documented ever attempted in Canada, perhaps in America" (Letter to T.E. Lee, 12 Feb. 1955) After reading "Antiquity of the Sheguiandah Site" and corresponding with Lee, Krieger (Letter to T.E. Lee, 30 Sept. 1961) said, "I can't see for the life of me what more anyone could have done with that site in the time you spent on it."

There was discussion of what would happen when, inevitably, Lee would finally have to leave the site. It was big enough and sufficiently complex for many years of work yet. "Normally," he said, "I would welcome investigation by other institutions as a cross-check on my own work. However, the publicly expressed opinions by representatives of several institutions show quite clearly that they would dig in the usual six-inch levels. In my opinion ... the whole story of the site will be lost" (Letter: T.E. Lee to J. T. Sanford, 26 Mar. 1954).

He was particularly horrified at the prospect of Greenman digging at Sheguiandah, "following his statement directly to me that he was not keeping levels" at George Lake 1 (Letter: T.E. Lee to F. Knechtel, 3 July 1954). "What would our interpretation be, if it were not for [our recognition of] the presence of projectile points between the two levels of big blades? I think we would have had a puzzle almost incapable of solution" (Letter: T.E. Lee to F. Ridley, 15 Apr. 1956).

Even with that key piece of stratigraphy in hand, there was puzzle enough. Initially, the central question was the origin of the till-like deposits in the Habitation Area. It took "three years of coaxing on my part," said Lee (Letter to B. McCary, 3 Sept. 1954), to get geologists interested in the site.

"In most situations," Lee observed (Letter to R. Woodbury, 13 Feb. 1956), "any one geologist can briefly examine a body of till and state that it is till -- provided that it does not contain artifacts or raise other problems." But glacial till, he had come to realize, cannot be identified with certainty from its own characteristics. It has to be demonstrated by ruling out all other possibilities. Because of the artifacts, the geologists "sought every other possible explanation -- and have put me to unending labour to show them either right or wrong, point by point."

In such a case, "it is not enough just to call in a geologist, or many geologists, as I have," said Lee (Letter to A. Dreimanis, 3 Feb. 1956). It had been necessary to "evaluate and sort the welter of conflicting and changing views ... As time went on, the observations of one could be used to counter the arguments of another" (Letter: T.E. Lee to R. Woodbury, 13 Feb. 1956).

For his part, Sanford's (1971) geological interpretations "borrowed liberally from the archaeological evidence ... the artifacts have been used to separate strata of till in the same manner in which any fossils might be used."

Though an understanding of the site was fundamentally dependent on geology, the primary significance of the site remained archaeological. Man's tools were in the deposits of interest to the Pleistocene geologist, but who had made them?

"I have checked every bit of literature available to me in [the National Museum] library," said Lee (Letter to E.B. Sayles, 8 Sept. 1958) "and am unable to discover anything comparable to Sheguiandah short of Europe .... It is not enough to compare individual specimens; the complex itself must be duplicated or nearly matched."

"But who has reported any such assemblages?" asked Lee (Letter to E. Antevs, 14 Feb. 1956). "I've consulted F. Roberts, W Hurt, D Wenner, B McCary, J Witthoft, Sayles, and Wormington -- all say that no such assemblages are known to them. Where do I go from here?" The site, he believed, deserved the attention of the highest authorities in archaeology, whoever they might be.

Summary

Lee had spent 488 days on this site. Apart from plunging both him and Sheguiandah into that great controversy over the first peopling of the Americas, what was accomplished through the work there?

Lee's first goal, to break Greenman's monopoly, was accomplished in the moment of discovery. Lee then used his hold over the big site in what Greenman had regarded as his territory to force some cooperation. Greenman eventually sent six specimens, out of a reported 150 from George Lake, to the National Museum in Ottawa. In return, Lee conducted Greenman and his crew over the Sheguiandah Site, showing them "everything."

His second great drive was to bring in Ontario's first law protecting its archaeological heritage -- and above all, the Sheguiandah Site. The law was passed, but with a fatal flaw: only sites specifically designated were covered. Only after a second appeal to the public was Sheguiandah added to the list.

In these battles, Lee had called upon the Indians of Manitoulin Island to support the preservation of their past, and they had responded. They also held a ceremony in which the name, Kitchi Donegeshin ("Great Searcher") was conferred upon him (Kennedy 1952). In turn, he offered them a 300-year-old skeleton he had salvaged nearby, and in a secret ceremony helped them rebury these ancestral bones in their traditional way (Kenyon 1953). Privately, they told Lee it was the first time the white man had ever given them anything back. The groundwork was thus laid for respectful cooperation, rather than confrontation (Figure 2.17).

The public interest in archaeology that Lee's campaign had aroused was complemented by his subsequent efforts to serve the cause of public education at Sheguiandah. Displays, lectures, and daily on-site tours brought the subject home to thousands of people.

Archaeological interest was focused to a high degree of intensity in the crews, who were largely drawn from the ranks of the fledgling OAS. Lee wanted to see the large crews continued and encouraged. "In this one experiment," he said (Letter to R. Marshall, 13 Sept. 1952), "a nucleus was formed around which to build a party of almost any size, and surely that was worthwhile .... As a result, I have recommended 5 for summer employment. I want to thank the OAS for the great assistance rendered in an emergency situation."

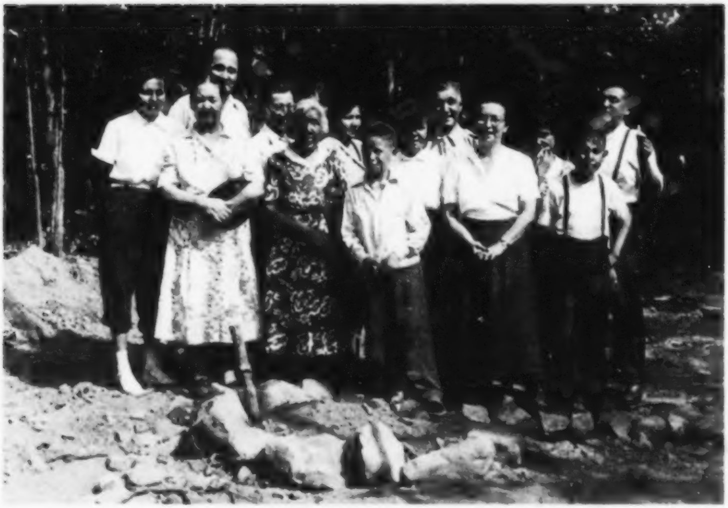


Figure 2.17. Gathering of Manitoulin Ojibways in 1953 at the reburial of ancestral bones previously salvaged by Lee's crew. Left to right: Annie Gabow, Mrs. McGregor, Bill McGregor, Alfie Debassige, Victoria Trudeau, Josette Debassige, Jimmy Gabow, Margaret Gabow, Andrew Trudeau, Agnes Manitouabi, Mrs. Ense, Gregory Ense, Joe Ense.

The call to geologists and other specialists widened the investigation into a cross-disciplinary effort. Lee sought not only their opinions, but their participation. In the Habitation Area, in the swamps, and in the hilltop ravine, they had to adjust their thinking to accommodate the presence of artifacts. It wasn't long before the geologists learned how to see Indian sites elsewhere, too, and were reporting them to him. They were pleased for themselves, as well as helpful; they told him that his trenches were revealing features that might never have been discovered otherwise.

Coming at it as an archaeologist, Lee moved from showing geological visitors the deposits he found puzzling, to digging at places and to depths they determined for him. His final year's work became a fundamentally geological effort devoted to the gathering of sedimentological data. After he was forbidden to dig at Sheguiandah again, he made serious efforts to pursue graduate studies in Pleistocene geology. But at heart and in practice, he remained an archaeologist. And, said Sanford (1971), "it is certain that the archaeological data have shed considerable light on the sequence of geological events, and that a proper chronology is dependent on the application of both disciplines."

Thomas E. Lee's years at the site profoundly changed his ideas of what was important in archaeology. "I have found over 400 sites in Ontario," he said, "and would throw them all away if by so doing I could save the Sheguiandah site. Why read a primer when a library of literature is available? The evidence is there -- all of the means required for proving man's presence in remote times. We may search for many a year for what we are rejecting here."

Acknowledgements

This chapter has benefited from careful critical review in the manuscript stage by Geof Burbidge, Helen Devereux, Ian Dyck, Barbara Gaertner, Paul Karrow, Richard Morlan, Kim Sayers, and Peter Storck. Elizabeth O'Leary of the Antevs Reading Room facilitated my access to Antevs' files in the University of Arizona in Tucson. I thank Geof Burbidge and Paul Hamilton for extensive use of their computers in connection with the fabric studies. I am particularly grateful to Geof for his detailed consideration over many years of all facets of glacial geology involved, even to the point of travelling to Manitoulin Island to jointly examine the site with me. Discussions with him and with other geologists, notably Archie Stalker, have provided perspective on both historical and more current interpretations in the field. My own understanding of the original excavations was expanded by the recollections of former crew members Barbara Bennett Lee, Glenna Woolley Roberts, David Sanford, and Ruth Marshall Tovell. I thank Clayton Kennedy for giving me permission to use his father's photographs. I also thank Patrick Julig for inviting me to the re-excavation in 1991, for going through the original collections in the Museum of Civilization with me in 1996, and for asking me to write this chapter. Above all, I have deep appreciation for how my father, Thomas E. Lee, made Sheguiandah such an integral part of my life, without ever making me feel it had to be my life.

References

Allmendinger, R.W. 1988. *Stereonet, version 3.1: a plotting program for orientation data for the Macintosh Plus, SE and II Computers.*

Andrews, J.T. 1971. Methods in the analysis of till fabrics. In *Till: a Symposium*. pp. 321-327.

Anonymous. 1953. 10 Resolutions passed by W.I. at Manitoulin's Convention. *Manitoulin Expositor*, Sept. 24, 1953, p.6.

Barnett, P.J. 1992. Geological investigations of the Pleistocene deposits at the Sheguiandah archaeological site, Ontario. *In* Report on Phases 1 and 2 of the Archaeological Master Plan for the Township of Howland, Ojibways of Sucker Creek, and the Sheguiandah First Nation. D.A. Robertson and R.F. Williamson, eds. Archaeological Services Inc, Toronto, pp. 73-82.

Bell, R. 1866. Report of Mr. Robert Bell. *Geology of Canada 1866: Report of Progress from 1863 to 1866*. Geol. Survey of Canada, Ottawa, pp. 165-179.

Bell, R. 1878. Report on geological researches north of Lake Superior and east of Lake Superior. *Geology of Canada: Report of Progress for 1876-77*. Geol. Survey of Canada, pp. 193-220.

Bodsworth, F. 1952. They're looting our history: Canadian scientists are racing against time to save priceless relics. *Maclean's*, Nov. 1, 1952, pp. 18-19, 30-31, 34.

Bryan, K. 1950. Flint quarries: the sources of tools, and at the same time, the factories of the American Indian. Papers of the Peabody Museum 17(3).

Cooper, M.S. and Robertson, D.A. 1992. Archaeological research in the study area and its vicinity. *In* Report on Phases 1 and 2 of the Archaeological Master Plan for the Township of Howland, Ojibways of Sucker Creek, and the Sheguiandah First Nation. D.A. Robertson and R.F. Williamson, eds. Archaeological Services Inc, Toronto, pp. 23-29.

Doig, J. 1979. Storm Over Ungava: an embattled maverick's long quest to rewrite Canada's History. *Th Canadian*. Southam Publishers, Toronto. March 3, pp. 10-13.

Greenman, E.F. and Stanley, G.M. 1943. The archaeology and geology of two early sites near Killarney Ontario. *Papers of the Mich. Acad. of Science, Arts and Letters*, Vol. 28: 505-531.

Griffin, J.B. 1979. The origin and dispersion of American Indians in North America. In *The First Americans: Origins, Affinities, and Adaptations*, ed. by W.S. Laughlin and A.B. Harper, Gustav Fischer, New York, pp. 43-55.

Hinshelwood, A. 1990. *Brohm Site Archaeological Project: 1987*. Ontario Conservation Archaeology Report, North Central Region Report 27. Ontario Ministry of Citizenship and Culture.

Jackson, L.J and McKillop, H. 1987. Patterns in Ontario Prehistory: the Sheguiandah Site, 1952-1956. *Arch Notes*, 87(1): 9-15.

Julig, P.J., Storck, P.L., Mahaney, W.C. 1994. Re-investigations at Sheguiandah: the application of a geoarchaeological approach. In *Great Lakes Archaeology and Paleoecology: Exploring Interdisciplinary Initiatives for the Nineties*. R.I. MacDonald, ed. Quaternary Sciences Institute, Univ. of Waterloo, pp. 237-262.

Kamb, W.B. 1959. Ice petrofabric observations from the Blue Glacier, Washington, in relation to theory and experiment. *Journal of Geophysical Research*, 64: 1891-1909.

Kennedy, C. 1952. 10,000 Years Ago. *Weekend Picture Magazine*, Sept. 6, pp. 26-27.

Kenyon, R. 1953. Scientists Squabble at Relic Site: Manitoulin Mixup has Two Skeletons. *The Telegra* Aug. 4.

Lee, T.E. 1953. A preliminary report on the Sheguiandah Site, Manitoulin Island. *National Museum of Canada Bulletin* 128: 58-67.

Lee, T.E. 1954a. The Giant Site. *National Museum of Canada Bulletin* 132: 66-69.

Lee, T.E. 1954b. The First Sheguiandah Expedition, Manitoulin Island, Ontario. *American Antiquity*, 20(2): 101-111.

Lee, T.E. 1954c. A Report on the 1954 Archaeological Investigations of the Sheguiandah Site, Manitoul Island, for the Honourable W.J. Dunlop, Minister of Education for Ontario.

Lee, T.E. 1954d. American Anthropological Association Meetings, Dec. 27-30, 1954, Detroit: Archaeological Section. MS on file, Lee Family Archives.

Lee, T.E. 1955a. The Third Sheguiandah Expedition, Manitoulin Island, Ontario. Manuscript on file, Le Family Archives.

Lee, T.E. 1955b. The Second Sheguiandah Expedition, Manitoulin Island, Ontario. *American Antiquity*, 21(1): 63-71.

Lee, T.E. 1955c. The Fourth Sheguiandah Expedition, Manitoulin Island, Ontario. Report to the Honourable W.J. Dunlop, Minister of Education, Parliament Buildings, Toronto, Ontario.

Lee, T.E. 1956. Position and meaning of a radiocarbon sample from the Sheguiandah Site, Ontario. *American Antiquity*, 22(1): 79.

Lee, T.E. 1957. The antiquity of the Sheguiandah Site. *Canadian Field Naturalist* 71(3): 117-137.

Lee, T.E. 1963a. A Point Peninsula Site, Manitoulin Island, Lake Huron. *Bulletin of the Massachusetts Archaeological Society*. 26(2):19-30.

Lee, T.E. 1963b. "Unpublished" Sheguiandah? Comments by the Editor. *Anthropological Journal of Canada*, 1(4): 32.

Lee, T.E. 1964a. The Glover-Ridley Exchange re. Donated Specimens. MS on file, Lee Family Archives.

Lee, T.E. 1964b. Sheguiandah: Workshop or Habitation? *Anthropological Journal of Canada*, 2(3): 16-24.

Lee, T.E. 1965. *Archaeological Investigations at Lake Abitibi, 1964*. Centre d'Etudes Nordiques, Traveaux Divers 10, Institut de Geographie, Univ. Laval, Quebec.

Lee, T.E. 1968. The question of Indian origins, again. *Anthropological Journal of Canada*, 6(4): 22-32.

Lee, T.E. 1974a. A comment on the "Shield Archaic." *Anthropological Journal of Canada*, 12(4): 23-28.

Lee, T.E. 1974b. Sheguiandah viewed in 1974. *NEARA Newsletter*, 9(2): 34-37.

Lee, T.E. 1976a. Autobiography. Manuscript on file, Lee Family Archives.

Lee, T.E. 1976b. Taped memoirs. Transcript on file, Lee Family Archives.

Lee, T.E. 1979. Sheguiandah and Early Man *Geology of the Manitoulin Area*, Michigan Basin Geological Society Special Publication No. 3: 87-89.

Lee, T.E. 1983. Son of Deac, Native of Port Bruce. *Anthropological Journal of Canada* 21: 29-45.

Liberty, B.A. 1955. *Sheguiandah Archaeological Report: Geological Setting.* Statement prepared for publication with the permission of the Deputy Minister, Dept. of Mines and Technical Surveys, Ottawa.

Martin, P.S. 1958. Pleistocene Ecology and Biogeography of North America, *Zoogeography*, American Acadamy for the Advancement of Science.

McDonald, H.L. 1952. Manitoulin Archaeological Finds and Need for an Antiquities Act. Script for Radio CBC News Roundup, Aug. 28, 1952.

Pettijohn, F.J. 1975. *Sedimentary Rocks*. New York: Harper & Row.

Roberts, G.W. 2001. ... more of the '50s. *Arch Notes*, New Series 6(4): 21.

Sanford, J.T. 1957. Geologic observations at the Sheguiandah Site. *Canadian Field Naturalist*, 71(3): 138-148.

Sanford, J.T. 1971. Sheguiandah reviewed. *Anthropological Journal of Canada*, 9(1): 2-15.

Wormington, H.M. 1957. *Ancient Man in North America*. Denver Museum of Natural History, Fourth Edition.

Chapter 3

Sheguiandah in 1991: The Role of Heritage Planning in the Reinvestigation of the Site

David A. Robertson, Eva M. MacDonald and Ronald F. Williamson

Abstract

The first large-scale field investigations to occur at the Sheguiandah site since Thomas Lee's excavations of the 1950s were, to a large extent, made possible by the fact that over the past decade, the Province of Ontario has been in the process of transferring many of its heritage planning and management roles to municipal governments. In doing so, the need has arisen to provide local planning authorities with the tools they require in order to make responsible management decisions. Master plans of archaeological resources represent one such tool. One of the major components of the Master Plan of Archaeological Resources for the Township of Howland, the Sheguiandah First Nation and the Ojibways of Sucker Creek was the re-assessment of the Sheguiandah site in order to resolve competing claims as to the quarry's antiquity, as well as to address several significant planning issues that the site raised.

The data recovered from the site during the course of the Master Plan have provided much of the foundation upon which detailed analysis of the Paleoindian occupations of the northern Lake Huron area will rest. It is, therefore, necessary to consider the context in which this information was collected, and to recognize that the underlying causes that permitted renewed access to the site had relatively little to do with the long term research interests of academic archaeology. Rather they were the outcome of several other trends—such as the increasing role of cultural resource management activities and the increasing participation of First Nation communities in the investigation of their pasts—that have significant implications for the future course of archaeology in Ontario.

Résumé

Les premières études à grande échelle menées au site de Sheguiandah depuis les excavations de Thomas Lee dans les années 1950 ont, dans une large mesure, été possibles parce que, au cours de la dernière décennie, la Province de l'Ontario déléguait progressivement bon nombre de ses fonctions de planification et de gestion du patrimoine aux administrations municipales. Ainsi, les autorités locales ont dû se doter des moyens nécessaires pour prendre des décisions de gestion responsables, notamment de plans directeurs des ressources archéologiques. L'une des principales composantes du plan directeur des ressources archéologiques du canton de Howland, de la Première Nation Sheguiandah et des Ojibways de Sucker Creek a été la réévaluation du site de Sheguiandah afin de régler les affirmations conflictuelles concernant l'ancienneté de la carrière et de trouver une solution à des questions importantes de planification touchant le site.

The Sheguiandah Site: archaeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario, edited by P. Julig. Canadian Museum of Civilization, Archaeological Survey of Canada, Mercury Series Paper 161, 2002.

Les renseignements recueillis au cours de l'exécution du plan directeur ont fourni la plupart des bases sur lesquelles reposera l'analyse détaillée des occupations paléoindiennes au nord du lac Huron. Il est par conséquent nécessaire d'examiner le contexte dans lequel ces renseignements ont été recueillis et d'admettre que les raisons sous-jacentes du nouvel accès au site avaient relativement peu de rapport avec les intérêts scientifiques à long terme de la recherche archéologique. Elles sont tout autres : le rôle grandissant des activités de gestion des ressources culturelles et la participation accrue des communautés des Premières Nations aux études sur leur passé, qui ont eu des retombées non négligeables sur le déroulement de l'archéologie en Ontario.

Introduction

In the summer of 1990, the Township of Howland, together with the Councils of the Ojibways of Sucker Creek and the Sheguiandah First Nation elected to prepare a master plan of archaeological resources. The ultimate objective of the master plan (Archaeological Services Inc. 1992a; LORD Cultural Resources Planning and Management Inc. 1993; Archaeological Services Inc. and Gore & Storrie Limited 1993) was the establishment of a series of planning and management guidelines for archaeological resources within the Township and the Reserve lands, which together encompass an area of approximately 260 square kilometres (Figure 3.1). That there was a need for such a study is a reflection of the trend towards a greater sharing of responsibilities between the provincial and local governments in terms of planning for the conservation and wise use of archaeological resources in the face of development and land use change. The benefits to the community at large were also seen to include an enhanced understanding of the region's heritage, and the delineation and protection of archaeological sites, some of which might eventually provide recreational and educational opportunities in archaeology for the general public.

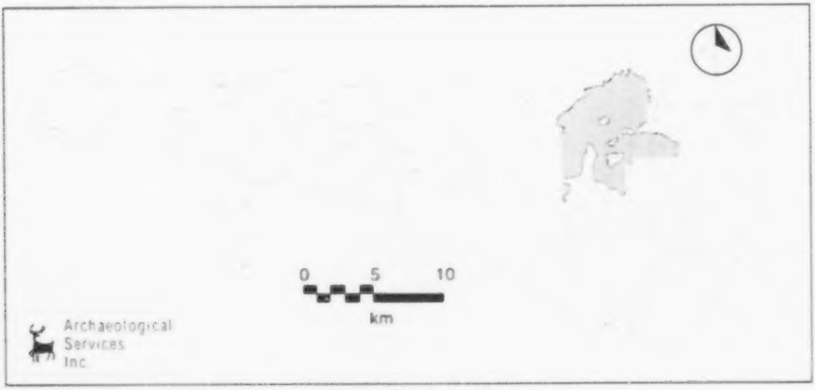


Figure 3.1. The Archaeological Master Plan study area

One of the natural foci of the master plan was the Sheguiandah site itself, since Thomas Lee's extensive work there in the 1950s had left a prominent—and in some respects contentious—legacy to the community. Recognizing that Sheguiandah was a critical yet fragile source of information concerning the earliest inhabitants of the region, Lee successfully lobbied the Province to have a 36 hectare parcel of land within the hamlet of Sheguiandah protected under a new statute, *The Archaeological and Historic Sites Protection Act* (1953). The Sheguiandah site was, in fact, the first archaeological site to be so designated in Ontario (Lee 1955). The designation, which was subsequently renewed under the successor *Ontario Heritage Act* (1980), imposed significant land use restrictions on the owners of property within the affected area. The bounds of the designation, however, extended well beyond the known distribution of significant archaeological deposits. Accordingly, one of the specific goals of the master plan research was to determine more precisely the boundaries of the Sheguiandah site and to provide sound scientific reasons for exactly which of the designated lands within the hamlet should remain protected.

The archaeological master plan thus furnished an opportunity for the first large-scale, detailed field survey and excavations to occur at Sheguiandah since Lee's own work there ceased with his departure from the National Museum. In the interim, the site had largely faded from consideration in Ontario archaeology as a consequence of the many outstanding questions surrounding the date of the earliest occupations. In a detailed survey of the Paleoindian period published around the same time that the master plan was initiated, for example, Sheguiandah merited only a footnote (Ellis and Deller 1990:37), although Patrick Julig and his colleagues had already begun the process of reassessing the site (Julig and Storck, Julig and Mahaney, this volume).

In providing the context for the 1991 reinvestigation of the site, the master plan—which represents the increasing role of municipal governments in managing the province's archaeological heritage—also exemplifies two other emergent trends in Ontario archaeology. The first of these is the fact that cultural resource management (CRM) projects have become increasingly central in identifying and understanding the past, and many such studies have led to a number of interesting examples of co-operation and communication among disciplines, while at the same time rendering the dichotomy between purely "academic research" and "resource management" increasingly untenable. The second is that archaeologists are coming into greater contact with Aboriginal communities, as a result of the shift toward self-government and the need for consultation concerning the management of Aboriginal heritage resources. This changing relationship between archaeologists and First Nations has potential benefits for both parties.

Each of these themes, as they relate to the reinvestigation of the Sheguiandah site, merits further exploration, as do some of the results of the research of the master plan that was conducted throughout the remainder of the study area. The latter included archaeological survey, the compilation of an inventory of Aboriginal traditional use sites, the development of an archaeological potential model for municipal and First Nation planners, and the identification of a series of planning protocols concerning the archaeological resources of the area.

Archaeological Master Planning: The Need for a Local Response

Although there is considerable breadth to the provincial government's involvement in archaeological resource conservation, the role of the local planning authority has become even more crucial. Planning and land-use control are predominantly local municipal government responsibilities and the impact of municipal land-use decisions on archaeological resources is significant, especially since locally approved developments on private lands constitute the majority of land-disturbing activities (Hansen 1984).

One way that the Ontario government has been encouraging municipalities to protect their archaeological heritage, therefore, is through their support in the preparation of municipal master plans of archaeological resources, since these represent an effective tool for planning for their conservation. Master plans typically involve detailed research into the environmental characteristics and historical development of a region, as well as a re-examination of previously documented archaeological sites. These data are then mapped and analysed, to generate and test increasingly sophisticated predictive models for prehistoric site locations. The ultimate objective of master plans is the design and implementation of planning policies and procedures that address the specific needs for archaeological resource conservation and interpretation in the municipality in question, and most importantly from their perspective, will provide a yes-no answer for the planner who must determine the need for pre-development archaeological assessment. Over a dozen of these studies have been conducted to date in Ontario, many of which also addressed other heritage resources including built structures, cultural landscapes and intangible heritage.

In light of these concerns, the first phase of the Howland master plan consisted of a detailed review of regional environmental, archaeological and historical data in order to determine the character of human settlement in the study area. This material served, in turn, to provide a sound basis for the construction of a predictive model which identified various zones of archaeological potential. An attempt to test the model was then undertaken through a campaign of archaeological survey throughout the study area, which included reassessment of known sites and investigation of previously un-surveyed areas. Another important activity was the collection of oral histories among the Ojibways of Sucker Creek and the Sheguiandah First Nation in order to identify traditional use sites and significant landscape features. This work, which was incorporated into the study at the specific request of the two band councils, resulted in the compilation of a set of cultural data, specific to sites used by the local First Nations that would be available for consideration during the final planning phase of the master plan. Furthermore, the collection of such ethnohistoric data would allow for a generalized reconstruction of seasonal activities which, in turn, could also be used to help refine the predictive model.

While the increasing role of local government in the planning and decision-making process concerning archaeological resources—together with the response in the form of master planning—is occurring throughout much of the province, the presence of the Sheguiandah site introduced a rather more unique element to the Howland master plan. Of particular interest with respect to the site were issues that revolved around the status, effectiveness and implications of its designation under the *Ontario Heritage Act*, and the potential tourism opportunities the site offered to the region. These local concerns, which typically fall within the purview of the private sector CRM industry, rather than the research interests of the academic community, were the stimuli that actually provided an opportunity to carry out the first extensive scientific fieldwork to be completed at the site since Lee's controversial interpretations were published.

The Designation of the Sheguiandah Site

While Thomas Lee was unable to complete his planned research at the Sheguiandah site, he nevertheless was successful in having it designated as a protected site under provincial law (*The Archaeological and Historic Sites Protection Act*, 1953). In his effort to preserve the site and have it recognized as being of international significance, Lee was much assisted by William J. Patterson, the editor of the *Manitoulin Expositor*, who had himself been active in Paleoindian research in southern Ontario during the 1930s (Jackson and McKillop 1987; Jackson *et al.* 1987).

The extent of the designation, which encompassed an area of 36 hectares, was based less on firm scientific determination of the site's actual size than on a desire to place a large buffer zone around the primary archaeological deposits that Lee had documented during the 1950s. The terms of the designation, which continued to be applied under the *Ontario Heritage Act* (1980), stipulated that no activities may be carried out on the site that involve excavation, alteration of the ground, or the removal of objects. These restrictions were intended to prevent subsurface features from being disturbed or destroyed by looters, and to ensure that landowners do not inadvertently cause damage to the site. They were not intended to restrict less intrusive land use practices, or to prevent agricultural or horticultural activities on lands previously disturbed by ploughing.

Although the Sheguiandah site was to be protected through this designation, the master plan investigations suggested that it has, nevertheless, been subject to disturbance through a variety of agencies. In addition to the extensive damage caused by looting, the site area has been affected by the installation of a hydro line, pedestrian traffic that has caused erosion of talus slope deposits, a variety of recreational activities, and disturbance associated with residential activity (Julig and Storck 1992:48-49). Another potential source of disturbance emerged in the fall of 1990 when the construction of a water treatment plant was proposed on the southeastern side of the designated site.

The resulting archaeological assessment (Figure 3.2) documented several activity areas along a level beach terrace (~188 m A.S.L.) associated with the rising waters of Lake Nipissing (*ca.*6,000-5,000 B.P.) within one of the proposed locations of the plant (Archaeological Services Inc. 1991). The material collected from this portion of the site included a single nodular core, 64 shatter fragments, 30 flakes, and the basal portion of an Archaic side-notched projectile point similar to many of those that Lee had previously recovered from the site (e.g., Lee 1957: Figure 4). Additional finds were also made closer to the modern shoreline, in another of the proposed development areas, where the presence of at least four clusters of artifacts was noted (Figure 3.2).

At least part of the reason for the failure of the designation to protect the site must be attributed to the fact that although the designation was duly published, according to the Act's requirements, it appears that little effort was made to consult with the local community at any time during the process. Direct formal notice to the affected landowners was never provided, nor was there an appreciable effort to explain the implications of the legislation to them, or to inform them of their own rights under its terms. Those people who could, potentially, act as the most effective custodians of the site were left largely uninformed about the need to protect it. In addition, there existed considerable resentment and fear among those who did know about the designation, and who were vaguely aware of its implications. In numerous cases, property within the designated zone was purchased in good faith with the expectation that it could be used for the land uses indicated in the municipal planning documents, yet the designation had the effect of expropriating certain of the approved uses.

In light of these issues, one of the major objectives of the master plan was to determine more precisely the actual extent of the archaeological deposits and to provide sound scientific reasons for exactly which of the 36 hectares designated within the hamlet should remain protected. A major component of the 1991 investigations, therefore, was a detailed survey of the entire designated area (Figure 3.2). The results of these activities permitted redefinition of the limits of the site, and the identification of zones of varying significance and sensitivity within the designated site area (Figure 3.3). The area of greatest concern, "Zone 1," incorporates the summit and upper slopes of the hill, forming the core area of the site complex. The bounds of this zone, which extend over an area of 9.6 hectares, are primarily delimited by the Nipissing beach strandline at the 198 metre contour interval. It is in this area that the vast majority of primary, comparatively undisturbed, deposits associated with the Late Paleoindian occupation(s) are to be found. This zone includes those features and locales that were most extensively investigated in the 1950s (*i.e.*, "Mystic Ridge," the "Habitation Area," the "Hillside Dump," the "Mid-Quarry Ridge" and Swamps 1-4).

Extending over an area of 13.7 hectares within the current designated area, "Zone 2" includes those plough-disturbed archaeological deposits that lie above the Nipissing strandline. Within a one hectare pasture on the south slope of the hill, for instance, 1,951 artifacts were surface collected from 953 individual stations located above the 204 metre contour line, despite the fact that surface visibility was comparatively restricted (Archaeological Services Inc. 1992b). The material recovered from this portion of the site includes 21 unifacially worked tools and 22 bifacially worked tools (e.g., Figures 3.4 and 3.5). Zone 2 also encompasses most of the lower slopes of the hill where potentially undisturbed deposits related to later occupations of the site are known or likely to occur.

"Zone 3" incorporates those remaining portions of the designated site (12.2 hectares) in which no evidence of significant archaeological deposits was documented, and where assessment of the local physiography indicated that there is relatively low potential for the presence of such deposits. These areas were found to be confined to the northern and northeastern portions of the original designation area. In addition, a fourth zone, encompassing an area of 1.5 hectares, was identified along the southern side of the site, in order to capture those remaining lands above the Nipissing strandline that were not included within the original designation, but where deposits related to the primary use of the hill top quarry are likely to be present.

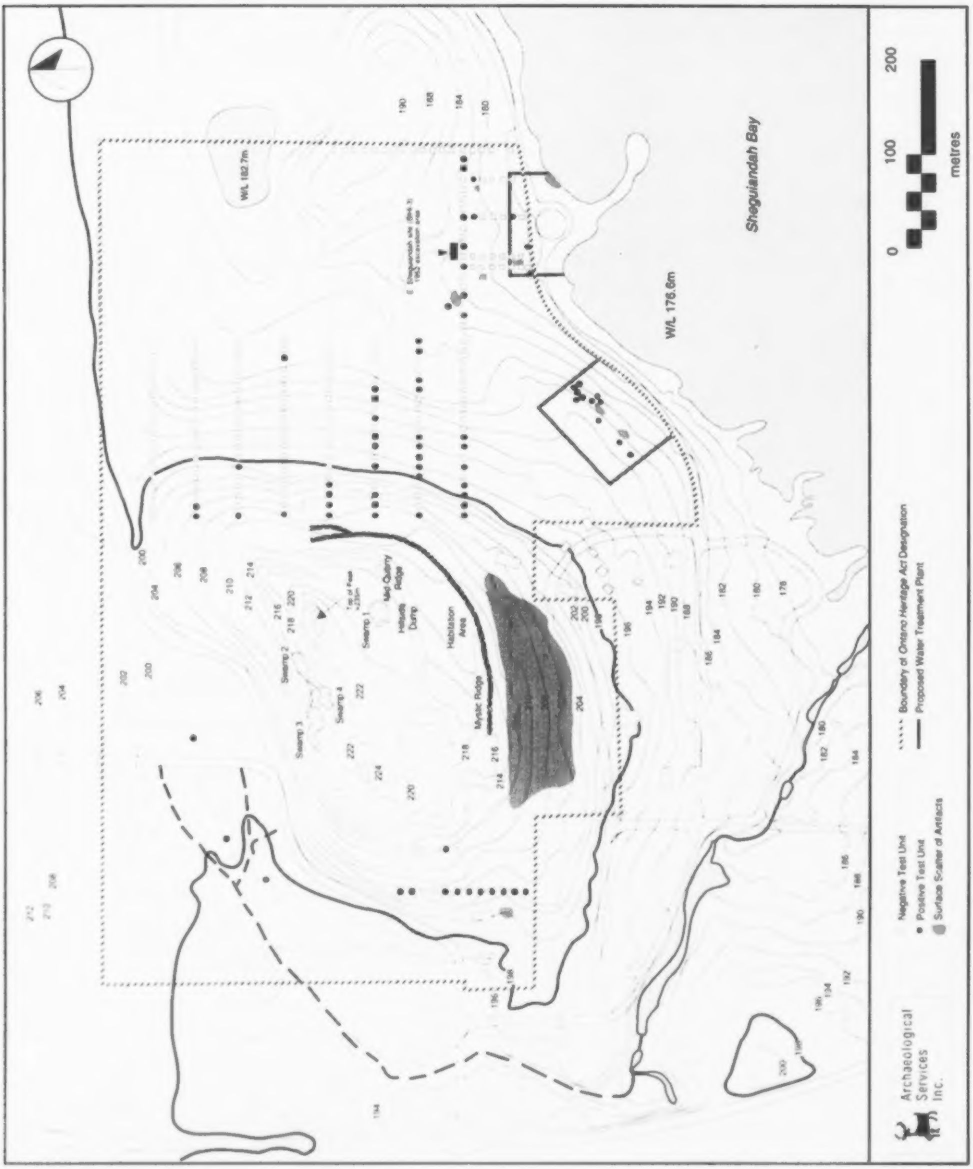

W/L 182.7m
Sheguiandah site (BIHI-1) 1953 excavation area
W/L 176.6m
Sheguiandah Bay
Top of Peak +235m
Mid Quarry Ridge
Hillside Dump
Habitation Area
Mystic Ridge
Swamp 1
Swamp 2
Swamp 3
Swamp 4
Negative Test Unit
● Positive Test Unit
Surface Scatter of Artifacts
Boundary of Ontario Heritage Act Designation
Proposed Water Treatment Plant
0
100
200
metres
Archaeological Services Inc.

Figure 3.2. The Sheguiandah Archaeological Site: area of the 1953 designation and 1990-1991 assessment and survey.

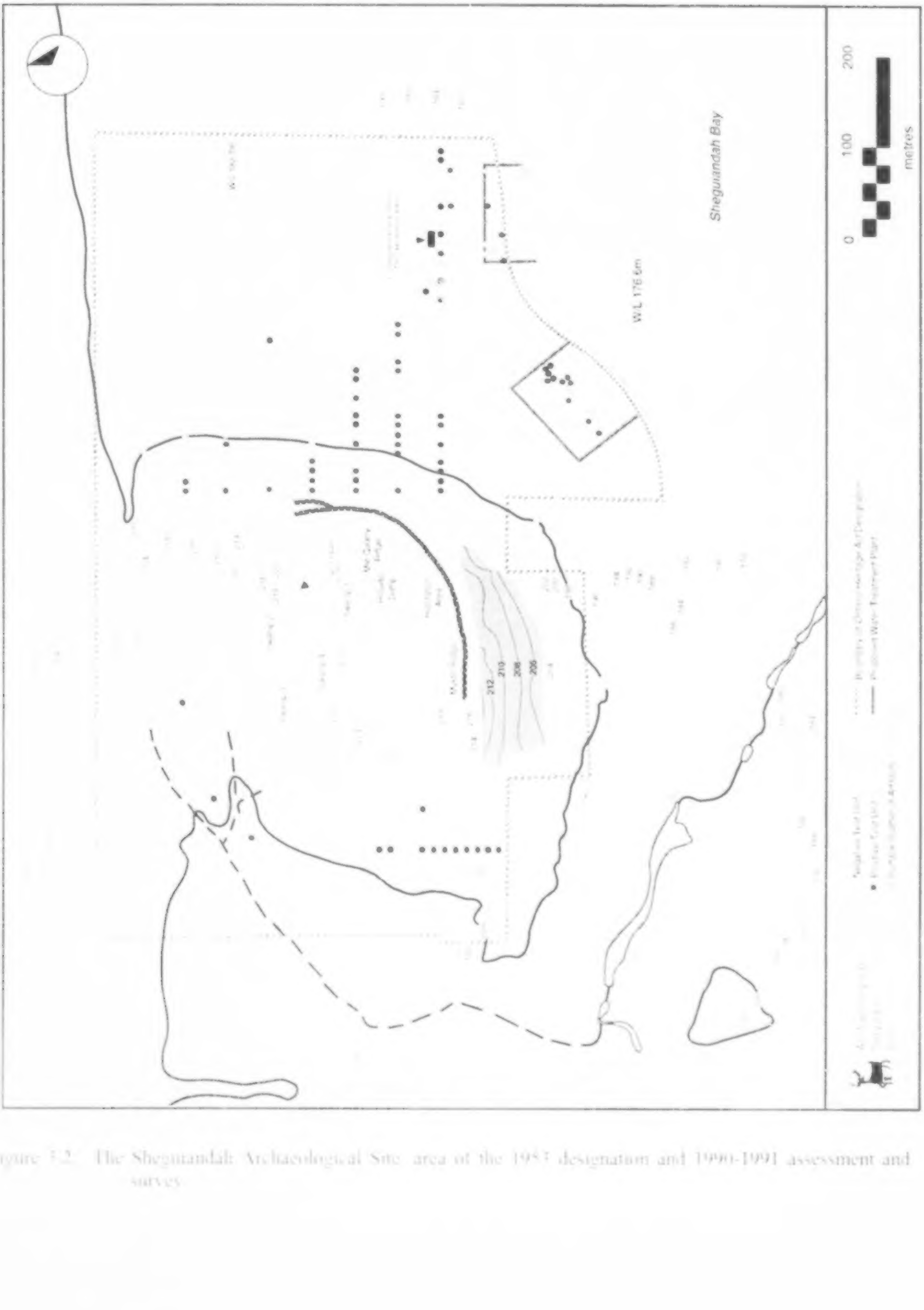

Sheguiandah Bay
W.L. 176.6m
212
210
208
206
0
100
200
metres

Figure 3.2. The Sheguiandah Archaeological Site: area of the 1953 designation and 1990-1991 assessment and survey.

The refinement of the original designation in this manner provided the basis for a series of recommendations concerning permissible land use practices that were fine-tuned to each of the properties involved, rather than a single set of conditions applied uniformly over the entire designation area.

The Master Plan as a Research Opportunity

At the same time that these planning issues were being considered, it was also clear that if the site was to be developed as a tourist attraction, the various competing claims as to the date of the earliest occupations first had to be resolved. This required the reinvestigation of the areas originally excavated by Lee, in order to examine the stratigraphy and geology of the site. As is apparent from the other contributions to this volume, the fieldwork initiated at the Sheguiandah site was a multi-disciplinary study with contributions from numerous specialists in the fields of archaeology, geology and palynology. The fact that the opportunity for much of the primary data collection arose as a direct consequence of the need for a master plan is largely typical of the broader changes that have occurred in archaeological activity over the last decade (Kelley and Williamson 1996:17; Ferris 1997:235-238). Over 80% of the 3,000 sites added to the Ontario provincial database during the past six years, for example, were documented as a result of CRM activity and there has been a three-fold increase in the number of annually documented sites from 15 years ago (Ferris 1997:236-237). This new and enhanced site database has, in turn, led to the opportunity of compiling better informed culture histories and regional site sequences than had been possible previously (Ellis 1990:1-2). Equally important, however, the project demonstrated that CRM activities and academic research are not mutually exclusive and, in fact, co-operation between these two camps provides significant opportunities for all involved in the discipline archaeology (*cf.* Ferris 1997:243).

The Master Plan as a Reflection of Archaeology's Changing Relationship with First Nations

Archaeologists are coming into greater contact with Aboriginal communities, as a result of the shift toward Aboriginal self-government and the need for consultation concerning the management of Aboriginal heritage resources. That the increase in the degree of consultation and communication between archaeologists and First Nations is also largely driven by local concerns is demonstrated by the fact that although cultural anthropologists concerned with the ethnography of Aboriginal cultures seem to be less in evidence than has been the case in the past (Kelley and Williamson 1996:16), five of the 14 master plans to be completed in Ontario have received the direct support of band councils, including Sheguiandah and Sucker Creek, Walpole Island (Nin.Da.Waab.Jig Research Centre and Cataraqui Archaeological Research Foundation 1990), the Oneida Nation of the Thames (Mayer 1987), the Beausoleil Band Council of Christian Island (Museum of Indian Archaeology 1989), and the Wahta Mohawks (Archaeological Services Inc. *et al.* 1994a, 1994b).

The character of such contacts are radically different from the interaction between ethnographers and Aboriginal peoples of a few decades ago. Not only has the context changed in social, economic and political terms, but the topics of conversation are likely to be radically different as well. Cooperative ventures, the collection of emic views, or the incorporation of mul-

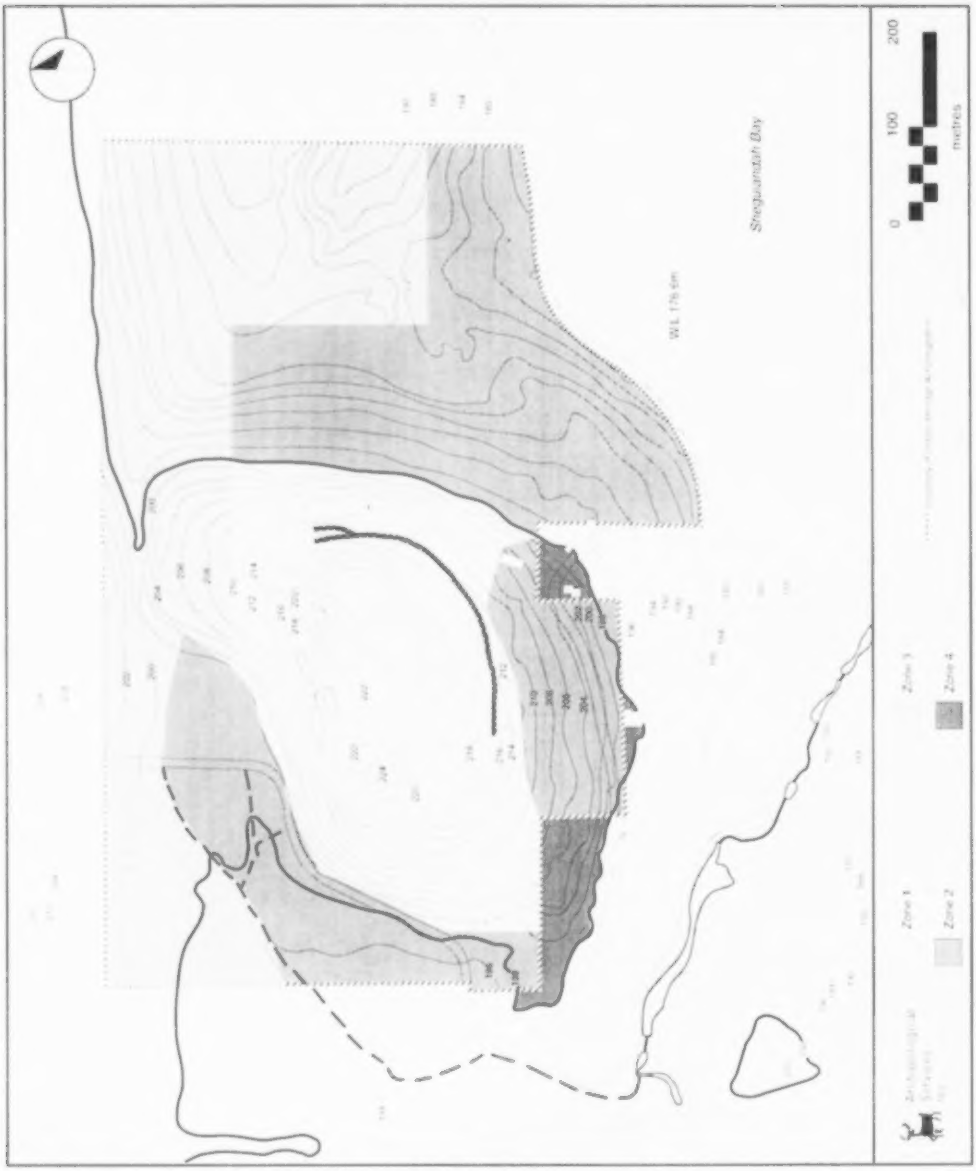

Sheguiandah Bay
W.L. 176 m
0
100
200
metres
Zone 1
Zone 2
Zone 3
Zone 4

Figure 3.3. The recommended redesignation of the Sheguiandah site based on the survey results

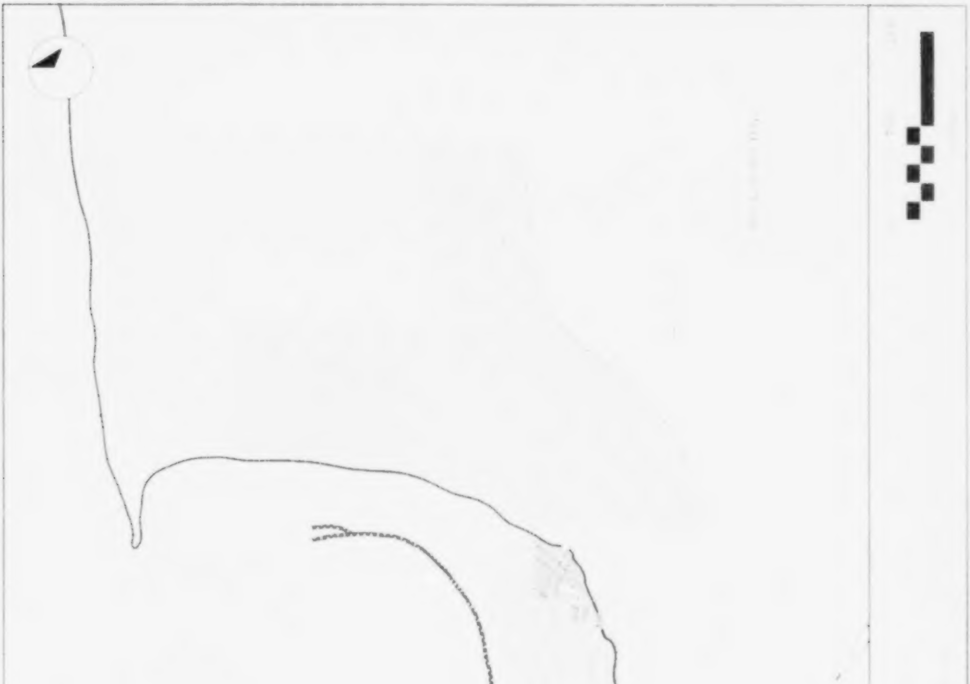


Figure 3.3 The recommended redesignation of the Sheguiandah site based on the survey results

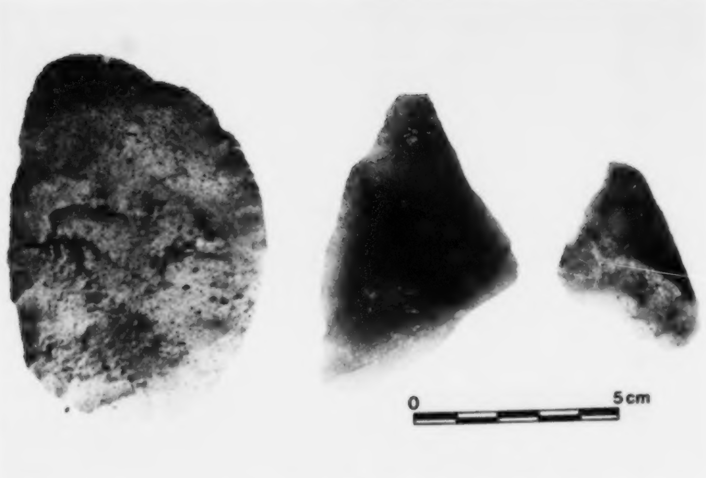


Figure 3.4. Selected artifacts from the south pasture of the Sheguiandah site. From left to right: unifacially worked cutting tool of Fossil Hill Formation chert and quartzite biface fragments.

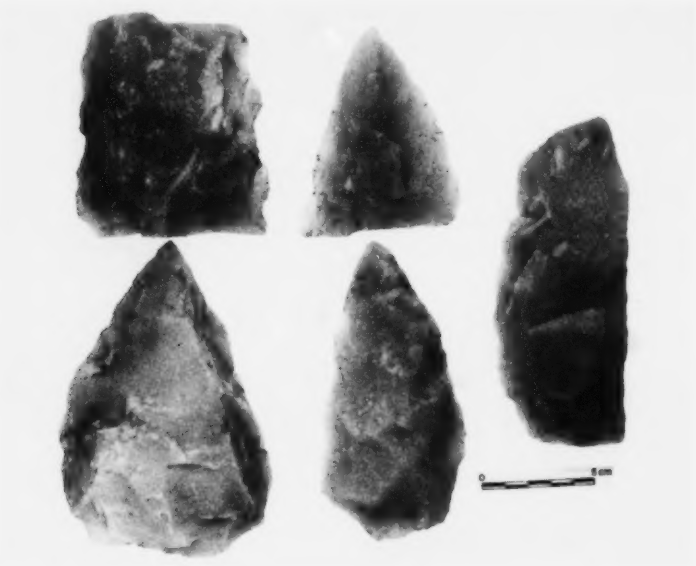


Figure 3.5. Selected artifacts from the south pasture of the Sheguiandah site. Top row from left to right: fragment of unfinished rectangular biface, tip fragment of biface. Bottom row, left to right: fragment of unfinished ovoid biface, trianguloid biface, unfinished biface fragment. All artifacts are quartzite.

tiple voices reflect not only the political realities of the emerging relationship, but also contemporary societal attitudes. Perhaps the widespread perception of the necessity for the politically weak to be heard has, in a sense, empowered archaeologists to accept Aboriginal history from First Nations people themselves—a kind of applied yet politically correct anthropology (Williamson and Kelley 1996:15-16). Those First Nations that have participated in the master planning process have recognized that archaeology can contribute to a collective knowledge of the past, and also view such studies as providing another opportunity by which to ensure that the traditional knowledge of their communities will be recorded.

For their part, archaeologists are broadening their thinking to include all aspects of heritage valued by society. Collaboration with First Nations as well as other heritage specialists has led archaeologists to view archaeological sites within the larger context of dynamic, cultural-historical landscapes rather than as static, isolated places in time and space, in a manner that is also consistent with a recent, all-encompassing definition of Ontario's heritage as:

> *all that our society values and that survives as the living context —both natural and human —from which we derive sustenance, coherence and meaning in our individual and collective lives* (Ontario Heritage Policy Review 1990:18-19).

Such changing perspectives are paralleled within theoretical archaeology as well, with the emergence of "landscape" as an analytical concept that is distinct from more strictly positivist subsistence-settlement approaches (e.g., Bender 1992; Ingold 1992, 1993; Thomas 1993; Tilley 1994). The most important consideration of the landscape approach is that meanings are both attached to and gathered from our physical surroundings. Landscape represents the need of all people to establish their place within their own understanding of the natural and human order of the world. Perceptions of landscape are shaped by the immediate experience of living in, and moving through, the world by interaction with its physical features and the other human and non-human creatures that dwell therein and have left traces of their own actions and understandings. Thus landscape is subjective and personal, formed as people, "weave their way through spaces, encountering and interpreting the world, gaining new understandings and recalling past connotations" (Thomas 1993:29). Places, the paths that linked them, and the historical and social associations which they recall together form the mythologised and anthropomorphicized landscapes (Bender 1992:742) that are inextricably tied to ideas of community.

To have failed to consider the oral tradition of the people of Sucker Creek and Sheguiandah during the formulation of the master plan, therefore, would have been to ignore one of the most important aspects of their heritage. The documentation of traditional use sites, landscape features and their Ojibway place-names is a practical application of this broadened perception of heritage, and one that was viewed as essential in order to ensure the consideration of these sites during both Aboriginal and non-Aboriginal development projects. Not only will the sites have been identified as a guide for conservation, but in the process, the oral histories have been conserved as well. This will provide non-Aboriginal people with the opportunity to learn something of Ojibway history in its written form as well as become a valuable source of information recorded before this generation of Elders die. Indeed, the value of recording the traditional teachings had previously been recognized by the Ojibwe Cultural Foundation, which conducted an oral history project among Aboriginal communities in the Manitoulin District in 1989 (Ojibwe Cultural Foundation 1989).

In addition, consideration of such types of information can only serve to inform our own understanding of the archaeological data we more routinely study. The complexity of the ethnographic record makes it clear that archaeological data alone cannot provide sufficient context to assign culturally specific meaning to cultural diversity in the archaeological record (e.g., Trigger 1989).

The Archaeological Survey: Beyond the Quarry

While the 1991 fieldwork carried out at Sheguiandah itself was intended to begin the process of clarifying some of the outstanding questions surrounding the age and cultural affiliations of the quarry and its associated sites, the master plan also represented an attempt to place the site within a broader context. The presence at the site of an immense supply of quartzite suitable for lithic tool manufacture undoubtedly has profound implications for any detailed reconstruction of the settlement and subsistence patterns of the island's prehistoric populations. In order to achieve such an understanding of the prehistoric use of the Sheguiandah quarry at the local level, a major component of the master plan was a programme of archaeological survey throughout the study region.

Thomas Lee undertook what constituted the first systematic archaeological survey on Manitoulin Island in June of 1951. The research was a continuation of his survey of southwestern Ontario, which involved the examination of local collections followed by site visits. The goal of the Manitoulin survey was to "strengthen or disprove certain theories concerning cultural movements across the province in prehistoric times" (Lee 1959:89). This referred to the possibility that the island represented a link between the movement of peoples from northern Ontario to the Bruce Peninsula. In large part this research was planned in order to discover material comparable in age to that claimed by Emerson Greenman for some of the quartzite artifacts recovered at the George Lake sites near Killarney on the Bruce Peninsula (Greenman and Stanley 1942; Greenman 1943, 1946). Despite Lee's original goal of surveying all of Manitoulin Island, with a particular emphasis on its eastern portions, his focus narrowed to an area of less than two kilometres in diameter around the hamlet of Sheguiandah. This was no doubt a result of both his limited funding and the magnitude of the material encountered at the Sheguiandah site. The survey resulted in the documentation of 13 archaeological sites, nine of which fall within the master plan study area (Figure 3.6, Table 3.1). The master plan survey project was structured to complete several specific tasks. First among these goals was the re-examination of archaeological sites that Lee had recorded, or which were documented during the compilation of traditional use sites. Secondly, areas identified as being of special interest to each of the different client groups were examined for the presence of archaeological remains. Finally, areas deemed to be of moderate to high archaeological potential, which could be surveyed through field walking, were examined in order to obtain a representative sample of site distribution that could be incorporated within the project's site potential model.

As a result of the field work, 11 new sites were recorded. Several of these are clearly associated with the Sheguiandah site, and may be contemporaneous with the earliest quarrying activity there.

Reassessment of Lee's Sites

Four of the sites that Lee had documented could not be reassessed in detail during the master plan survey. Incorrect or ambiguous locational descriptions, combined with unsuitable field conditions inhibited rediscovery of the Giant (BlHl-1) and Station (BlHl-7) sites. Inability to secure property access prevented examination of the Bass Lake 3 (BlHl-8) and Bass Lake 4 (BlHl-9) sites, although in the case of the former, large quantities of quartzite debris were visible on the surface of the site when viewed from the road. Detailed examination of the locales of the Bass Lake 1 (BlHl-5) Bass Lake 2 (BlHl-6) and the Sheguiandah Hill (BlHl-10) sites failed to yield any additional material. In the case of the Bass Lake 1 and 2 sites, shoreline erosion may have resulted in their destruction.

The East Sheguiandah site (BlHl-3) was originally discovered to the east of the main components of the Sheguiandah quarry, in a broad, level area between the base of the quartzite outcrop and the foot of a smaller hill to the east (Figures 3.2 and 3.6). Excavations were subsequently conducted on a limited scale in the area. In one locale, the presence of ceramic sherds bearing St. Lawrence Pseudo-Scallop Shell decoration, in association with quartzite and chert debitage, fire-cracked rocks and a hearth, resulted in the identification of a Middle Woodland Point Peninsula/Laurel campsite. A particularly interesting find was that of a large reworked Late Paleoindian biface, which Lee suggested had been collected from the quarry site and modified by the occupants of the later camp (Lee 1963).

Resurvey of the area during the course of field work at the Sheguiandah site (Figure 3.2) resulted in the discovery of several discrete clusters of artifacts, together with numerous more scattered finds of quartzite and chert, some or all of which may be associated with the Middle Woodland component, although no ceramics were encountered at any of these locales. Certainly the position of all these finds, well below the Nipissing beach ridge, and in close proximity to the modern shoreline, suggests a relatively late occupation.

An extremely dense surface scatter of quartzite debitage, measuring some five metres in diameter, was encountered approximately 100 metres to the southeast of Lee's excavation area. This scatter also yielded a hammerstone and a biface preform. The size and density of the scatter suggests that it was formed during a single, intensive episode of tool manufacture. A second, more diffuse activity area, located approximately 50 metres west of Lee's trenches was indicated by the discovery of a surface scatter of burnt and calcined bone which may represent the remains of a weathered hearth. Analysis of the finds (Thomas 1992) permitted the identification of beaver (*Castor canadensis*) and moose (*Alces alces*). Four clusters of quartzite and chert debitage consisting of three to 15 flakes were documented within a ten metre radius of the faunal material, however, no diagnostic material was recovered. Lithic material was also recovered 40 to 50 metres south of the Middle Woodland component, during the course of the 1990 assessment of the proposed water treatment plant. These items include several retouched quartzite flakes, a uni-

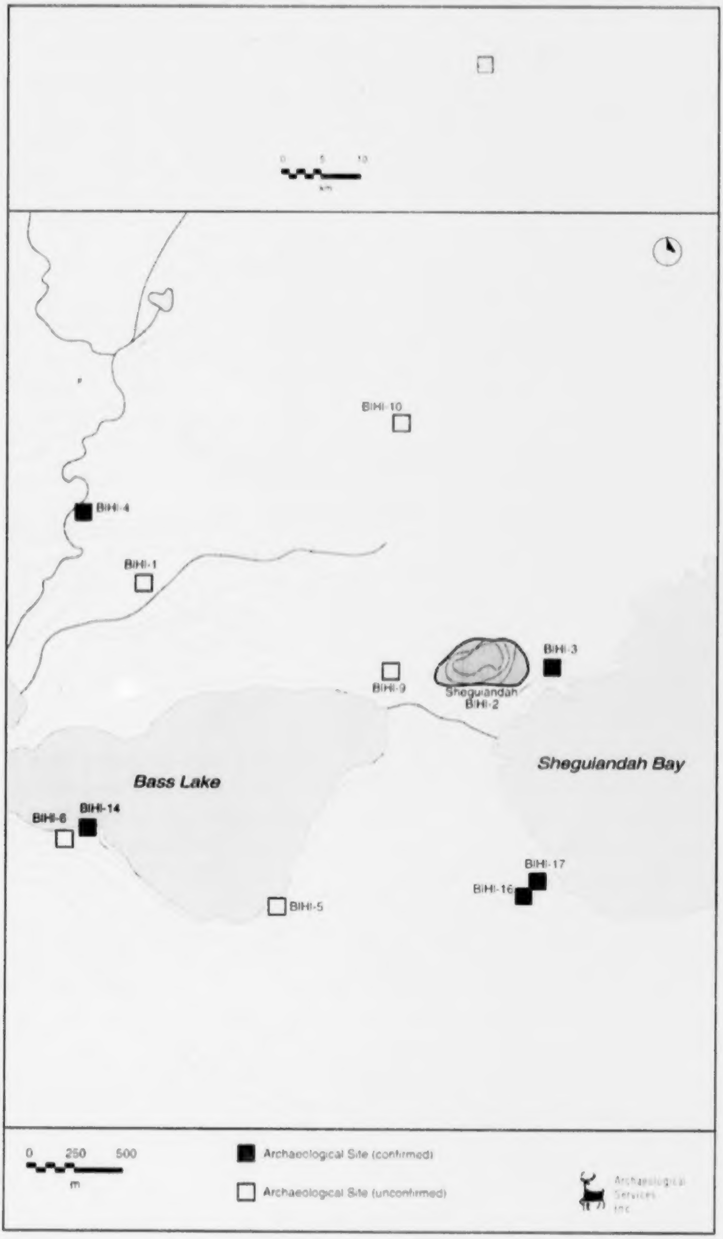

0 5 10
km
BlHl-10
BlHl-4
BlHl-1
BlHl-3
BlHl-9
Sheguiandah
BlHl-2
Sheguiandah Bay
Bass Lake
BlHl-14
BlHl-6
BlHl-17
BlHl-16
BlHl-5
0 250 500
m
Archaeological Site (confirmed)
Archaeological Site (unconfirmed)
Archaeological Services Inc

Figure 3.6. Archaeological sites within the vicinity of the Sheguiandah quarry.

Table 3.1: Archaeological Sites Discovered by Thomas Lee's 1951 Survey

Site Name (Borden)	Site Type and Affiliation	Description/Comments
Giant Site (BlHl-1)	Paleoindian/Archaic quarry and possible habitation site.	Diagnostics recovered were reported to include both broad and narrow leaf-shaped blades, as well as several variant forms. The site was considered to display affinities with the Sheguiandah site.
East Sheguiandah (BlHl-3)	Middle Woodland Point Peninsula/Laurel campsite.	Located to the east of the core area of the Sheguiandah site complex.
Northwest Sheguiandah (BlHl-4)	Chipping station of unknown date.	Seven non diagnostic artifacts recovered.
Bass Lake 1 (BlHl-5)	Undetermined.	Eight non-diagnostic artifacts recovered.
Bass Lake 2 (BlHl-6)	Undetermined.	Nine non-diagnostic artifacts recovered.
Station (BlHl-7)	Isolated find of unknown date.	Single non-diagnostic artifact recovered.
Bass Lake 3 (BlHl-8)	Believed to be closely associated with the Sheguiandah site (area is encompassed by an historic Aboriginal cemetery).	Twenty-nine non-diagnostic artifacts recovered.
Bass Lake 4 (BlHl-9)	Undetermined.	Seven non-diagnostic artifacts recovered.
Sheguiandah Hill (BlHl-10)	Isolated find of unknown date.	Located on a promontory on the ridge running along the lower slopes of Sheguiandah Hill.

facial quartzite end scraper, a small finely worked Fossil Hill chert biface and considerable quantities of quartzite debitage (*Archaeological Services Inc.* 1991).

The Northwest Sheguiandah site (BlHl-4) is situated at the top of the major quartzite ridge south of Sheguiandah Hill, on the east side of a creek where it drops off the ridge to form a waterfall, known locally as Buttermilk Falls, before it flows south into Bass Lake (Figure 3.6). The site is characterized by the presence on the surface of numerous quartzite blocks and large quantities of debris. Its areal extent is defined by large quartzite outcrops on the south and east and by the ravine leading down to the creek on the northwest. Investigation revealed several foci of lithic reduction activity and an additional seven artifacts were collected from the site. None of these are diagnostic of a particular culture or temporal period, however, an amorphous scraper made from Hudson Bay Lowland chert is similar to examples recovered from both the Sheguiandah site (e.g. Lee 1955: Figure.33 7-11) and the Middle Woodland component at East Sheguiandah (Lee 1963: 1-11). The balance of the assemblage consists of three interior flakes or reduction fragments, and two flake fragments, all of quartzite. One of the latter is derived from an extremely large bifacial thinning flake (+158 x 82 x 22mm) that likely spanned most of the biface from which it was struck.

Newly Documented Sites

The Bass Lake 5 site (BlHl-14) is situated on the west side of a small point on the south shore of Bass Lake, some 300 metres east of Lee's Bass Lake 2 (Figure 3.6). Three quartzite flake fragments, two of which are water-worn, were discovered during test pitting in the flat area immediately above the shoreline. The shore in this general area is undergoing considerable erosion, but no further finds were encountered during examination of the exposed soils above the present gravel beach. The limited number of finds prohibits clear definition of the site's nature or function and, in the absence of any diagnostic artifacts; its temporal and cultural affiliations must remain indeterminate.

In 1964, numerous artifacts were unearthed during quarry operations near the southern edge of the Sheguiandah Reserve. The material discovered is reported to have included an old pistol, a "tomahawk" made of white quartzite, a "spearhead" and several small "arrowheads" (Percy Nahwegezhics, personal communication, 1991). These remains were subsequently dispersed and lost through a variety of circumstances. Although quarrying was temporarily suspended upon discovery of these items, intermittent gravel extraction has taken place at the site in recent years, destroying most of the site area. The Gravel Pit site (BlHl-15), lies on gently sloping terrain near the base of a limestone ridge, the steep sides of which are strewn with large boulders of glacial origin (Figure 3.7). Today, the nearest permanent source of water lies over 500 metres away from the site, occurring as a series of cedar swamps, creeks and small lakes which ultimately drain into Turtle Lake to the southeast.

Five small, discrete clusters of artifacts (P1-P5) were recorded during investigation of the quarry (Figure 3.7). No diagnostic items were collected, however, the lithic assemblage consists of quartzite flakes representing virtually every stage in the reduction of raw material into finished tools.

Three of the artifact loci (P1-P3) were found within the exposed soils of the quarry face. Test pitting in the undisturbed soils immediately adjacent to these find spots failed to locate any additional material. A fourth locus (P4) was located to the north of P1 in the undisturbed soils immediately adjacent to the quarry face. Finally, P5 was discovered in topsoil which has been redeposited from the dirt road which marks the eastern edge of the quarry. Find spot P1 consists of four flake fragments that were distributed over an area less than three metres in length along the face of the quarry. Find spot P2, lying 45 metres to the northeast of P1, is made up of one bifacial thinning flake and five flake fragments, all located within five metres of one another. Situated approximately 18 metres northeast of P2 and extending over roughly eight metres of the quarry face, three late stage bifacial thinning flakes and five flake fragments constitute P3. Find spot P4 was located 7.5 metres north of P1, and consists of three late stage bifacial thinning flakes and one flake. It was discovered by test-pitting in the undisturbed soils immediately adjacent to the quarry face. This cluster of artifacts appeared to be no more than two to three metres in diameter. Finally, P5, consisting of one pressure flake and three flake fragments (one of Bayport chert rather than quartzite), was discovered in topsoil which has been redeposited from the dirt road which marks the eastern edge of the quarry.

Additional test pits were excavated in all moderate to high potential locations lying beyond the disturbed quarry area, but without any further positive results. The extreme disturbance that has taken place at the site has destroyed any evidence that may have aided in determining the exact nature of the various find spots and any relationships that may have existed between them. On the one hand, the small size of each of the artifact clusters may suggest that they represent several disparate events, however, it is equally likely that they represent individual foci of tool making activity at the edge of much larger site that has been destroyed by the quarry.

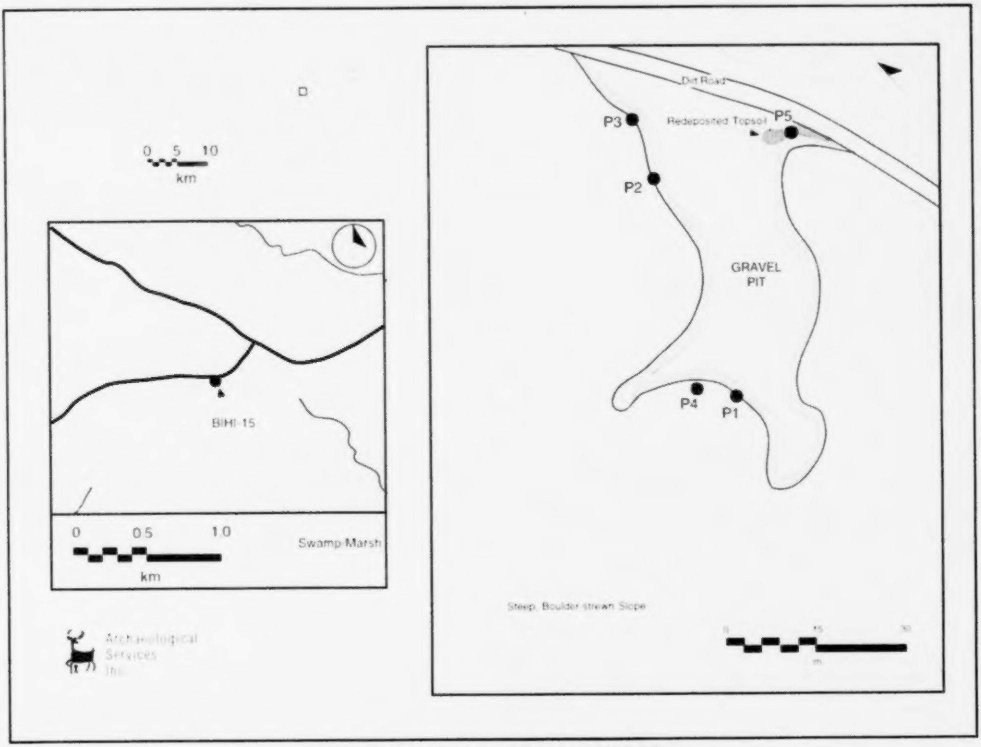


Figure 3.7. The Gravel Pit site (BlHl-15).

In the late 1960s and early 1970s, numerous artifacts were discovered in a garden plot located to the north of the main Sheguiandah First Nation settlement (Richard Shawanda, personal communication, 1991). The finds, which were donated to the Assiganack Museum in Manitowaning, include leaf-shaped bifaces and a corner-notched projectile point, suggestive of a Middle to Late Archaic period occupation (*c.* 8,000-2,000 B.P.). The Garden 1 site (BlHl-16) is located in a relatively low-lying area, the terrain of which gently slopes down to the shore of Sheguiandah Bay some 300 metres to the northeast (Figure 3.6). A small creek lies roughly 50 metres to the north of the site. Test pitting in the garden plot, which was overgrown with grass and low scrub, produced nine lithic artifacts, together with a single piece of fire-cracked rock, spread over an area measuring 35 metres in length by 10 metres in width. The finds of quartzite include four bifacial thinning flakes, two flake fragments, one of which may be from a pressure flake, and two reduction fragments/shatter. The remaining item is a large flake fragment of dark greyish-brown slate.

Artifacts were also reported to have been found in another garden plot, a short distance to the northeast of Garden 1 (Albert Waindubence, personal communication, 1991; Figure 3.6). Although the whereabouts of the finds are not known, they were reported to include a number of projectile points, and a probable biface. The garden plot, measuring roughly 60 by 12 metres but now overgrown, is located in a low-lying, poorly drained area west of the present shoreline of Sheguiandah Bay. Despite intensive test pitting in the former garden, only a single retouch flake of burnt Onondaga chert was found. The locale was, nevertheless, registered as the Garden 2 site (BlHl-17), in recognition of the likelihood that a substantial prehistoric component may be present on the property.

A total of seven, possibly related, sites were documented in valley land agricultural fields located to the northeast of Green Bay (Lake Manitou). This area (Figure 3.8) falls within the westernmost extension of a clay plain that stretches from the north shore of Green Bay east to Sheguiandah Bay (Lewis 1968). The clay plain, punctuated by occasional drumlins, was formed by the complex actions of glacial and lake level advances and retreats cutting through the limestone plains that form the backbone of Manitoulin. It is likely that much of the valley lands, defined by the flanks of a large drumlin to the east and southeast and escarpments to the north were submerged by Lake Manitou during high water episodes.

The East Face site (BlHm-1) site lies on a southeast-facing slope that overlooks the valley and gradually rises to meet the large ridge running from the south shore of Perch Lake to the northern edge of Blueberry Marsh. While only a single non-diagnostic artifact was recovered, this was located at the very edge of a cultivated area, suggesting that additional material may well lie beyond the margins of the field. The find consists of a quartzite bifacial thinning corner and edge removal flake.

The West Face (BlHm-2) site consists of a single item found on the gently undulating side of a west-facing slope which rises to the steep slopes of a large hill to the north of the community of Green Bay. Like the East Face site, the find, which is a unifacially retouched, early stage edge removal flake, was made near the edge of a ploughed field. Other material may, therefore, be present in the immediate area.

The Valley 1 site (BlHm-3) is one of five sites recorded in cultivated fields in the valley bottom, which appear to be focused on a small creek. Although relatively flat, numerous small, low knolls occur throughout the general area. Positioned on the southern edge of a low, flat-topped knoll, the Valley 1 site consists of eight quartzite artifacts distributed over an area of roughly 3,000 square metres. The assemblage consists of one early stage bifacial reduction flake derived from a very large core, two bifacial thinning flakes and five broken flakes, one of which was unifacially retouched. The bifacial reduction flake has been unifacially retouched along one edge, and bifacially retouched along another.

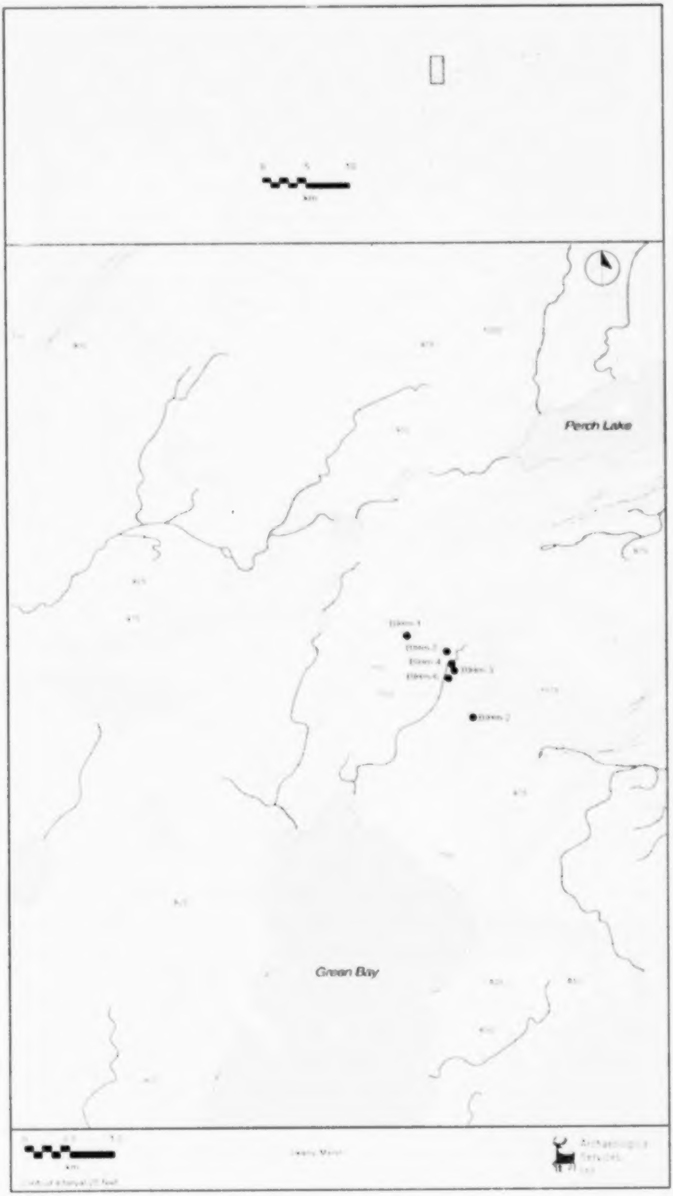

Perch Lake
Green Bay

Figure 3.8. The Green Bay sites documented during the master plan survey.

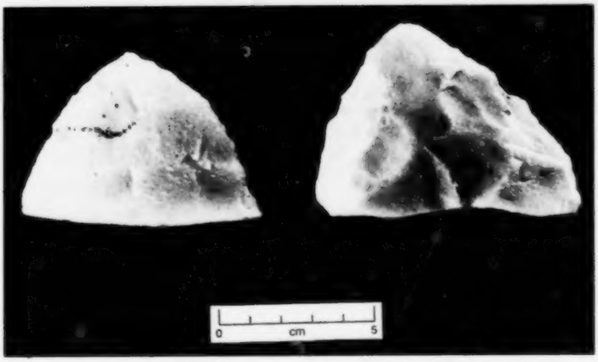


Figure 3.9. Tip fragment of a projectile point pre-form fragment recovered from the Valley 2 site (left) and tip fragment of a late stage biface from the Valley 3 site (right). Both artifacts are quartzite.

The Valley 2 site (BlHm-4) is located on an adjacent knoll, less than 50 metres southwest of Valley 1. The site is marked by a relatively dense scatter of lithic artifacts distributed over an area of at least 700 square metres, together with several outliers to the southwest. The complete areal extent of the site remains undefined, however, as it clearly extends further east, beyond the edge of the ploughed field in which it was encountered.

Twenty-six of the 48 artifacts visible on the surface of the site were collected for analysis. This material collected includes nine bifacial thinning flakes and 12 flake fragments of quartzite, two shatter fragments of Fossil Hill chert, one of which has been retouched, while the other is thermally altered. Most significant, however, was the discovery of two fragmentary thinned/late stage ovate or lanceolate bifaces and a finely-worked leaf-shaped projectile point preform (Figure 3.9).

Encompassing an area of approximately 600 square metres, the Valley 3 site (BlHm-5) is located on a slight knoll roughly 250 metres to the northwest of Valley 1 and 2. A total of 17 artifacts, 16 of which are quartzite, was present on the surface. These include a leaf-shaped biface fragment (Figure 3.9), a portion of a roughly ovate biface, a biface edge fragment, four bifacial thinning flakes, ten flake fragments, and a large shatter fragment of Bayport chert that exhibits usewear along one margin. All of the biface fragments are thinned with well pronounced or deep flake scars oriented in all directions and all exhibit sinuous edges, suggesting that they represent a middle stage in the bifacial reduction sequence.

The Valley 4 site (BlHm-6) is represented by four quartzite artifacts collected from a slight knoll 150 metres to the southwest of the Valley 1 and 2 sites. These finds, distributed over an area of roughly 180 square metres, consist of a small biface fragment, a bifacial thinning flake, one flake fragment and one reduction or shatter fragment. The relatively small size of the site, combined with the small number and limited range of the finds may indicate that it is a briefly utilized activity area, perhaps associated with the more substantial occupations at Valley 1 and/or Valley 2.

The presence of a large lithic scatter, the Valley 5 site (BlHm-7), was noted to the northwest of Valley 3, however, weather conditions prohibited its full documentation or the collection of artifactual material. Approximately 45 artifacts were encountered when the site was initially surveyed at five metre intervals. These were distributed over an area equal to or greater than that recorded for the large Valley 2 site. The onset of winter prevented completion of a controlled surface collection of the site, and once the property could be accessed in the following spring, field conditions were such that only one artifact was recovered. This item represents approximately one-quarter of a finely worked quartzite biface or pre-form.

Summary Interpretations

The field work conducted resulted in the recording of 11 new archaeological sites, doubling the existing inventory of sites in the study area. For the most part, the finds comprise small scatters of lithic debitage lacking formal diagnostic tools. Nevertheless, several tentative observations are possible. The overall impression formed by the newly documented sites is that they may be broadly assigned to the Late Paleoindian or Archaic periods. This is based on a number of factors, including: (1) the recovery of partial leaf- or lanceolate-shaped bifaces, similar to those found at the Sheguiandah quarry, from Valley 2, 3 and 5 sites; (2) the absence of ceramic material on any of the sites; and (3) the relatively small size of the sites and limited range of flake types which they contain. The short-term occupation of sites during both time periods can be expected to produce similar types of material residues which can only be distinguished from one another through the recovery of temporally diagnostic tool types.

The presence within the study area of a major source of lithic raw material could be expected to have a considerable effect upon the stone tool technologies of the local inhabitants. To a certain degree this is evident on the recorded sites. Quartzite predominates, never forming less than 75% of the material in any site assemblage. In general, the quartzite flakes recovered tend to be extremely large, suggesting that large blocks or cores of material were transported to ancillary sites as a source of large flakes suitable for expedient use and casual discard. Overall, there appears to have relatively little concern with wastage. Quartzite was a readily available and—to all intents and purposes—an inexhaustible resource.

The role of these small sites within the settlement systems of the early occupants of the area remain to be determined, however, they likely reflect the incorporation or "embeddedness" of toolstone procurement activities within the overall range of mobile hunter-gatherer subsistence pursuits. In general, hunter-gatherer quarrying was likely to have been fully integrated or "embedded" within the overall subsistence system (e.g., Binford 1979:259-261; Johnson 1984:235; Brumbach 1987:82; Holen 1991:404, 406; 409-410; Reher 1991:276-279; Robertson *et al.* 1997:505-506 ; but *cf.* Gould and Saggers 1985). That is, rather than lithic procurement forming the sole objective of travel to a known source area, such activities were likely to have been scheduled in conjunction with the exploitation of local faunal and plant resources. In all probability, these patterns likely apply to the Late Paleoindian period, given both the prevailing environmental conditions and the wide-ranging seasonal rounds hypothesized for individual bands (Ellis and Deller 1990:53, 62; Storck 1997:276)

Further survey in the study area, in order to provide a larger and more representative sample of material, and complete analysis of the finds should provide a firmer foundation for a more refined assessment of the response of the area's prehistoric occupants to the presence of the Sheguiandah quarry, both in terms of their lithic technology, procurement practices and their use of the range of potential resources present on Manitoulin Island.

The Traditional Use Site Inventory

The goal of the oral history component of the master plan was to produce a detailed inventory of traditional use sites that recognized Ojibway heritage and land use in the study area. In this way a set of cultural data, specific to sites used by the Ojibways of Sucker Creek and the Sheguiandah First Nation, would be available for consideration in the final planning stage of the project. The importance of documenting traditional use sites, landscape features and their Ojibway place-names cannot be over emphasized. Encoded in the oral tradition are the history, knowledge and values of people who are intimately connected to the land and water, and who view the natural world as part of their cultural heritage. By no means, however, was this inventory meant to be a definitive record of the Ojibway oral tradition; only sites that could be placed on a map and checked in the field were recorded for the purposes of the study.

Historical Overview

The people who make up the Ojibways of Sucker Creek and the Sheguiandah First Nation are descendants of Ojibway, Ottawa and Potawatomi people who came to settle permanently on Manitoulin Island during the nineteenth century. The Ojibway, Ottawa and Potawatomi Nations came to be known as the Confederacy of Three Fires during the sixteenth century and their history is closely linked (Benton-Banai 1987). The spiritual connection that they felt with Manitoulin Island was expressed by Head Chief Ocaita who spoke for the Chippewas, Ottawas and Winnebagos at the Council of 1818 on Drummond Island. As interpreted for the benefit of the Superintendent of the Indian Department he said, "when the Great Master of Life made us, he set us down in the Ottawa Island, [and] we were all white," meaning that they were pure (Higgins 1982: Appendix 1).

This is further evident in the cultural belief of the Ojibway who recognize the teachings of the seven prophets, each of whom foretold of a fire, or period of time in the life of the Anishnaubeg. As told by Eddie Benton-Benai (1987), during the second fire, after the direction of the sacred shell was lost, a boy would be born to point the way back to the traditional ways. He would point out the stepping stones of the Manitoulin Island chain as the path to spiritual renewal, and there religious beliefs would be rejuvenated. The word Manitoulin itself bears within it the Ojibway word for spirit, *manitou*.

At the time of contact with Europeans, the Southeastern Ojibway "homeland" was a vast area extending from the east shore of Georgian Bay, the north shore of Lake Huron, and the northeast shore of Lake Superior and into the upper peninsula of Michigan (Rogers 1978:760).

During the 1640s, the missionary Jérôme Lalemant documented a number of named groups of Algonquian speakers, including the Outanuan, who were said to inhabit an island 30 leagues long in a freshwater sea (Schmalz 1991). Each named group appears to have been politically autonomous and numbered several hundred people. The Jesuits further reported that the Algonquian tribes were nomadic, and could only be found at a fixed residence during certain seasons of the year, when the fish were plentiful (Rogers 1978:760). Manitoulin Island itself was first referred to in the *Jesuit Relations* by the name Ekaentoten, a Huron word, and the Jesuit mission of St. Peter was moved there in 1648 (Major 1934:3).

Commercial and military ties with the French during this period brought the Ojibway into conflict with the Iroquois, and battles were fought in Georgian Bay and on the north shore of Lake Huron. The Ojibway were relatively successful against the Iroquois and were only temporarily driven away from their homes on Lake Huron (Schmalz 1991). European diseases, warfare and periods of starvation, however, contributed to population reductions among the groups documented in the 1640s. Those who survived were freely adopted into remaining groups. By 1670, members of the Amikwa and Mississauga groups first documented on the North Shore could be found on Manitoulin Island (Rogers 1978:761).

During the eighteenth century, the Ojibway began to expand south of their former homeland and settled at various locations, including Lake Saint Clair east of Detroit, on the Humber River north of Lake Ontario, and at Matchedash Bay, east of Midland (Rogers 1978:761). When the territorial battles between the French and British in North America were concluded in 1763, the British instituted the policy of negotiating with the native people to purchase land for the Crown (Surtees 1969). By 1830, the Ojibway had been forced to cede much of their territory in southern Ontario and the British government came under increasing pressure to institute a policy that would assimilate native people into colonial society. A migration of Ottawas to British territory was also expected after the boundary disputes between the Americans and the British in the Upper Great Lakes was settled in 1828. Towards this end, Lieutenant Governor John Colborne made plans for the relocation of Algonquian-speaking groups from Michigan and the North Shore to a "refuge" on Manitoulin Island, beyond the limit of colonial settlements, where a government establishment would be founded (Wightman 1982:13).

In order for the government to institute this plan, it was necessary to carry out negotiations with the representatives of the Ojibway and Ottawa nations, who held acknowledged rights to Manitoulin Island. Thus a treaty for a general reserve was signed at Manitowaning, in August of 1836, by Colborne's successor, Sir Francis Bond Head and the Aboriginal chiefs (Canada 1905:112-113). According to the research of Ernest Debassige, half of the chiefs who signed represented various Ojibway bands from the north shore of Lake Huron; the remainders were Ottawa chiefs who were connected to the settlements at Arbre Croche in Michigan, or Wikwemikong (Ojibwe Cultural Foundation 1989).

Ideally, the new settlement at Manitowaning was to become a self-sufficient agricultural community, with its own craftspeople, school teacher, doctor and Anglican clergyman. Aboriginal groups who agreed to immigrate would be expected to live in permanent log homes, and the government would provide seed, livestock, tools and training in agriculture or skills such as barrel making and blacksmithing. A group of Ottawa families had already cleared some land at present day Wikwemikong and it was hoped that the same could be achieved at Manitowaning. The Wikwemikong settlement continued to remain separate from the one at Manitowaning, however, because its members were converts to the Roman Catholic church.

Although horticulture was certainly part of the traditional economy, pressure to stay in the new settlement year round was not universally accepted by the Ojibway (Wightman 1982:26). A government inquiry in 1843 found that not all of the Aboriginal people could be found at either Wikwemikong or Manitowaning. It was estimated that at least 150 people had settled in temporary structures elsewhere, while pursuing their seasonal rounds (Major 1934:24). The Manitowaning Superintendent George Ironside reported in the late 1840s that substantial settlements could be found on pockets of arable soil, and in proximity to good fishing and an adequate sugar bush, for example at Sheguiandah (Wightman 1982:31). These communities were bound together by internal land and water routes, and later on the territories surrounding the villages became associated with particular chiefs.

Increasingly, Manitoulin Island could no longer be considered isolated from mainland activities, especially after copper was discovered in the Upper Great Lakes during the 1840s (Wightman 1982:32). A regular steamer service was scheduled between Sault Saint Marie and southern Georgian Bay via the North Channel and Manitowaning became a stop on the route. In fact, arrangements were made for the community to supply the steamer with cord wood. A general trading station had already been established at Shebowananing (Killarney) and competed with the Hudson's Bay Company post at La Cloche for the trade in fish and maple sugar from Manitoulin Island (Myers 1969). Licenses to fish in waters around Manitoulin Island were being given to non-Aboriginal people despite protests brought to the government by Superintendent Ironside in 1848 (Wightman 1982:37), and a limited number of traders were allowed to reside in several of the settlements. In the 1850s, a community at Little Current was permanently established through the enterprise of George Obotossaway and others, who erected a wharf and began selling cordwood to the steamers going through the North Channel.

By 1857, few of the homes at the government settlement at Manitowaning were regularly occupied and the total Aboriginal population was perceived to be too small to warrant their exclusive use of the Island. In 1862 a new treaty was negotiated for Manitoulin Island and all the territory west of the Wikwemikong peninsula was surrendered to the Crown to be surveyed, with specific lands on the island to be set aside for Aboriginal use (Canada 1905:235-237). Aboriginal people have maintained, however, that control of 66 feet of the shoreline around Manitoulin Island (from the high water mark) had never been surrendered. Thus the sale of waterfront lots has alienated their right to land their boats anywhere on the Island. In order to compensate the Manitoulin First Nations, an agreement was signed between the Band Councils (with the exception of the Wikwemikong First Nation) and the Federal Government in 1991, whereby the Anishaubeg gave up this right in a cash settlement.

Collection of Oral Histories: Methods

Most of the people who were interviewed concerning traditional use sites in the area were 50 years of age or older, however, knowledge of traditional activities was also passed on by younger people. Interviews were conducted in the informants' homes and each session was structured around a set of 1:50 000 Ontario topographic maps that covered Manitoulin Island and the north shore of Lake Huron. The informants were asked to recall, in a site specific manner, the activities that the Anishnaubeg engaged in both on and off the Reserves. Mapping was not restricted to the Reserve lands in order that a full range of activities could be recorded. The approximate location of the sites was marked on the map in the presence of the informant, although the character of some sites precluded any boundary definitions.

Summary of the Inventory

A rich variety of traditional use sites was documented, including locations where hunting, fishing, trapping, plant collecting and farming activities were carried out, as well as travel routes, early settlements, cemeteries and landscape features associated with supernatural phenomena (Table 3.2). In all, 72 sites were recorded at Sucker Creek and 88 were recorded at Sheguiandah, many of which are still in use. As noted previously, five archaeological sites were reported as well, three of which were confirmed through field testing.

Locations related to fishing were the most frequently mentioned traditional use sites, demonstrating the importance of fishing in the Ojibway culture of Manitoulin Island. These include ice fishing, netting and spear fishing locations and important fish spawning areas. The preferred locations would appear to be those in open water, around Sheguiandah Bay and off islands in the North Channel of Lake Huron. Fishing was most intensive during the spring and fall and a wide range of fish could be caught, including lake herring, smelts, whitefish, pike, white sucker, salmon, sturgeon, muskie, yellow perch and bass. Fish was eaten fresh, smoked in the spring over a basswood or poplar fire, or canned.

The locations of five of the more common plants collected for medicinal or ritual purposes were identified. These include *weengushk*, or sweet grass (*Torresia odorata*), used in basketry and in purification rituals; *weken*, or bitter root (*Acorus calamus*) an aquatic plant used for relief from sore throats and chest colds; the inner bark of red willow bark (*Salix* sp.), used as a treatment for diarrhea, wild mint which serves as a cold remedy and as a treatment for upset stomach and chills; and *zheebawaussayauh* or jewel weed (*Impatiens capensis*), which is used as an antidote for poison ivy.

The production of maple sugar (*zeesabaukwutookaewin*) from sap collected in the spring was an important traditional subsistence activity among the Ojibway. In fact, maple sugar could be considered the first harvest in a yearly round of seasonal subsistence activities. Each family had a traditional holding within the sugar bush and a *sungahgon* (cache) of sap collection and processing items was kept in the bush from year to year. Nine separate sugar bush locations were recorded in the inventory.

One of the sugaring sites has at least two associated *sungahgonan* of birch bark containers which are over one hundred years old. One is a log structure measuring approximately 1.5 x 1.5 x 1.2 metres and the other is a depression covered with logs and earth. The historical association of these locations with ancestral spirits is extremely powerful and at Sheguiandah, the sugar bush has been the location of traditional healing ceremonies in recent years. Thus the site has taken on a sacred significance. Consequently, the question of how to plan for the conservation of features such as these must be answered within the context of their sacred character. Is it acceptable to leave these important caches exposed to the ravages of time and weathering? To what degree would altering their physical locations to conserve them for future generations disturb their sacred context? These important ethical questions are further complicated by the fact that the sugar bush is partly on the Reserve land and partly on private property in Howland Township. The Sheguiandah First Nation presently has little power to protect traditional use sites no longer within the Reserve boundary.

Natural formations imbued with spiritual significance include prominent ridges, rock outcrops, underwater currents and caves in the limestone escarpment. One such cave identified at Sucker Creek was said to be the home of a "white wolf or lion" who was to be treated with respect.

Table 3.2: Summary of the Traditional Use Site Inventory

	Number of Sites Documented	
Site Type	**Sheguiandah**	**Sucker Creek**
Sugar Bush	4	7
Berry Collecting	5	4
Bark and Wood Collection	2	3
Medicinal/Ritual Plant Collection	11	3
Farming	1	2
Fishing	20	13
Gull Egg Collection	3	0
Hunting & Trapping	2	12
Travel Routes	5	0
Camps	4	1
Habitations	1	12
Lookouts	6	0
Assembly Places	1	3
Archaeological Sites	5	0
Cemeteries & Isolated Graves	10	3
Sacred Sites & Natural Landscape Features	4	5
Other	4	4
Total	**88**	**72**

"The Rock" on the Sheguiandah Reserve is an impressive high point of land on the limestone ridge. The spirits are especially powerful at this location and deep rumblings could be heard within the Rock which foretold of disaster for the Anishnaubeg. The location is comparable to that of Dreamer's Rock on Birch Island, in that it was also a place where young men went during the Vision Quest, and where sweats are still held (Figure 3.11).

Stories of spirits that traveled underground and inhabited the lakes were recorded at Sucker Creek and Sheguiandah. A beach ridge that is visible between Mud Lake and a small lake to the northeast is said to follow the path of an evil spirit that lived in Mud Lake. Mud Lake was also associated with quicksand and attracted lightning during storms. A similar spirit lived in Bass Lake, but was said to move overland between the lake and Sheguiandah Bay; people were warned that a deep spot in Bass Lake associated with a whirlpool could pull boats under.

Another site of spiritual importance is located on the shore of Sheguiandah Bay, east of Sheguiandah Creek. It was a sacred place where the Elders came to pray, and the grave of a "medicine man" is also believed to be located in the vicinity of the mouth of the creek. It is significant that this area today is the focus of spiritual growth for the Anishnaubeg, and considerable effort has been devoted to developing the site as a public park and pow wow grounds. Such work is a strong affirmation of the spiritual importance of the site to the Anishnaubeg and also a positive example of the Ontario Heritage Policy Review's (1990:18) definition of development as "a pattern of change yielding broad social improvements, individual and collective fulfillment and general welfare." Yet this portion of Sheguiandah Bay, already the location of cottage developments for the last fifty years, may also experience increased pressure now that the 1990 Shoreline Treaty has been signed by the United Chiefs and Councils of Manitoulin and the Federal government.

Despite the density of traditional use sites documented around the Sheguiandah archaeological site (Figure 3.10), and the diversity of activities that these represent, it is interesting to note that no traditional use sites were recorded at the quarry. This may partially be explained by the fact that the site is not within Reserve land, and the greater portion is privately owned, hence the area has been "off-limits" to several generations of Aboriginal families. During the archaeological survey and reassessment of the designated site, however, a domed structure of bent saplings was discovered (Figure 3.11). The structure resembled the frame of a sweat lodge, while red paint had been scattered on the ground both within and around the structure. That the Sheguiandah site itself may have a sacred significance comparable to the other spiritual sites recorded during the study—or like the better-known site of Dreamers Rock, which occupies a similar prominent outcrop of Lorraine quartzite formation in the La Cloche range—should not be surprising, even if it was not considered appropriate to share this information in the context of the master plan.

Such spiritual associations may represent a continuation of the tradition, found among many Aboriginal societies of the Northeast, in recognizing the sacred character of quarries and toolstone (e.g., Hammell 1983; Moulton and Abler 1991; Williamson 1996; Robertson *et al.* 1997:506). That the Sheguiandah site represents a source of a hard, white, crystalline material, is particularly suggestive within the context of past Aboriginal symbolic systems and worldview (Hammell 1983). In contemporary terms, the antiquity of the site, whether understood in terms of

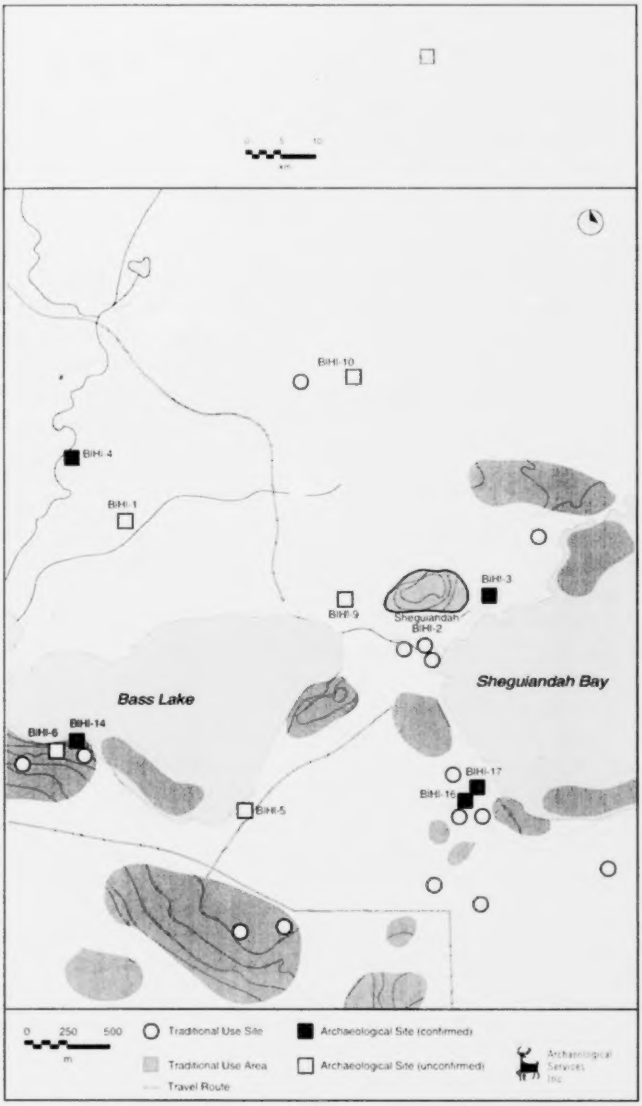

0
5
10
km
BiHi-10
BiHi-4
BiHi-1
BiHi-3
BiHi-9
Sheguiandah
BiHi-2
Sheguiandah Bay
Bass Lake
BiHi-6
BiHi-14
BiHi-17
BiHi-16
BiHi-5
0
250
500
m
Traditional Use Site
Traditional Use Area
Travel Route
Archaeological Site (confirmed)
Archaeological Site (unconfirmed)
Archaeological Services Inc.

Figure 3.10. Generalized locations of traditional use sites and areas within the vicinity of the Sheguiandah quarry.

Figure 3.11. A modern sweat lodge erected on the Sheguiandah site.

"pre-Clovis" (e.g., Lee 1957; Sanford 1957) or "Late Paleoindian" occupations, or on any other time scale is likely to be regarded as an affirmation of the antiquity and primacy of an Anishnabe culture that has survived to this day. The teaching of the Seven Fires Prophecy points to the stepping stones of the Manitoulin Island chain as the path to spiritual renewal, and at Sheguiandah, those stones are white: the colour of Life. It would be a mistake, therefore, to assume that the Sheguiandah site exists in isolation merely as a potential source of geological, palaeoevironmental and archaeological data. Rather it continues, as it has always done, to form part of the dynamic landscape that structures personal and social existence among the Anishnaubeg of Manitoulin and beyond.

Acknowledgements

It was only through the assistance and generosity of many people that the master plan could be completed. Logistical support was provided by the Township of Howland, the Ojibways of Sucker Creek and the Sheguiandah First Nation. Our thanks go to Frank Reynolds and Anthea Parlee of the Township, Chief Patrick Madahbee of Sucker Creek, and Chiefs Max Assinewai and Richard Shawanda of Sheguiandah, together with all their staffs.

The success of the oral history component of the master plan was largely due to the efforts of the liaisons chosen by the band councils to assist ASI staff. Richard Shawanda and Pearl Waindubence of Sheguiandah and Melvina Madahbee and Lois Nahwegahbow of Sucker Creek arranged the interviews in their respective communities, and helped to conduct the interviews over a four week period. They also proved to be invaluable resource people themselves. At Sheguiandah, those who assisted by sharing their knowledge of Manitoulin included Simon Esquimaux, Little Joe Esquimaux, Percy Nahwegezhics, Rita Fineday, Gertrude Atawish, Clara Waindubence, Albert Waindubence, Ed Simon, Eli Nahwegezhics, Evelyn Assinewai, Rose Pickford, Loretta Towers and Willomene Corbiere. At Sucker Creek, our thanks go to Ernest McGraw, Samuel Esquimaux, Clayton Abotossaway, Elie Madahbee, Corella Corbiere, Elsie Esquimaux, Evans Esquimaux, Ivan Madahbee, Jean Madahbee, Lawrence Madahbee, Earl Abotossaway, David Nahwegahbo, and Cecelia Bayers for their contributions.

Our thanks also go to Dr. Andrew Stewart, who reviewed the lithic material collected during the archaeological survey; Craig MacDonald, Ministry of Natural Resources, for his advice during the formulation of the oral history component of the project; Eva Skippen of the Howland-Little Current Centennial Museum, for her information and advice; and Honorine Wright of the Manitoulin Heritage Regions Project, for providing historic documentation compiled by that group.

Financial support for the project was provided by the Corporation of the Township of Howland, the Cultural Facilities Improvement Programme, Ontario Ministry of Culture and Communications (now Citizenship, Culture and Recreation), the Weston Foundation, the Ontario Ministry of Northern Development and Mines and the LAMBAC/Community Futures Programme.

References

Archaeological Services Inc. 1991. An Archaeological Assessment of Three Sites for a Proposed Water Treatment Plant, Sheguiandah Hamlet, Howland Township, Manitoulin Island, Ontario. Manuscript on file with the Ontario Ministry of Citizenship, Culture and Recreation, Toronto.

Archaeological Services Inc. 1992a. Report on Phases 1 and 2 of the Archaeological Master Plan for the Township of Howland, Ojibways of Sucker Creek and the Sheguiandah First Nation. Manuscript on file with the Ontario Ministry of Citizenship, Culture and Recreation, Toronto.

Archaeological Services Inc. 1992b. Report on the Controlled Surface Collection of the Eagleson Pasture at the Sheguiandah Site (BIHl-2), Manitoulin Island, Ontario. Manuscript on file with the Ontario Ministry of Citizenship, Culture and Recreation, Toronto.

Archaeological Services Inc. 1993. Phase 4 Implementation Report: Archaeological Master Plan for the Township of Howland, Ojibways of Sucker Creek and the Sheguiandah First Nation, Manitoulin Island, Ontario. Manuscript on file with the Ontario Ministry of Citizenship, Culture and Recreation, Toronto.

Archaeological Services Inc., Unterman McPhail Cuming Associates, Mount McGovern Co., Ltd., C. Carpenter, and S.L. Maltby. 1994a. Report of the Master Plan of Heritage Resources of the District Municipality of Muskoka and the Wahta Mohawks: Volume 1, Background Research. Manuscript on file with the Ontario Ministry of Citizenship, Culture and Recreation, Toronto.

Archaeological Services Inc., Unterman McPhail Cuming Associates, Mount McGovern Co., Ltd., C. Carpenter, and S.L. Maltby. 1994b. Report of the Master Plan of Heritage Resources of the District Municipality of Muskoka and the Wahta Mohawks: Volume 3, Conservation and Management Guidelines. Manuscript on file with the Ontario Ministry of Citizenship, Culture and Recreation, Toronto.

Bender, B. 1992. Theorising Landscapes and the Prehistoric Landscapes of Stonehenge. *Man* (New Series), 27: 735-755.

Benton-Benai, E. 1987. The Seventh Fire: Native Cultural Renaissance. *Boozhoo*, November 1987:7-11.

Binford, L.R. 1979. Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 35: 255-273.

Brumbach, H.J. 1987. A Quarry/Workshop and Processing Station on the Hudson River in Pleasantdale, New York. *Archaeology of Eastern North America* 15: 59-83.

Canada. 1905. *Indian Treaties and Surrenders from 1680 to 1890, in Two Volumes*. Ottawa: S.E. Dawson.

Ellis, C.J. 1990. Introduction. In *The Archaeology of Southern Ontario to A.D. 1650*, edited by C.J. Ellis and N. Ferris, pp. 1-3. Ontario Archaeological Society, Occasional Publication of the London Chapter, No. 5.

Ellis, C.J. and D.B. Deller. 1990. Paleoindians. In *The Archaeology of Southern Ontario to A.D. 1650*, edited by C.J. Ellis and N. Ferris, pp. 37-64. Ontario Archaeological Society, Occasional Publication of the London Chapter, No. 5.

Ferris, N. 1996. "I Don't Think We're in Kansas Anymore": The Rise of the Archaeological Consulting Industry in Ontario. In *Bringing Back the Past: Historical Perspectives on Canadian Archaeology*, edited by P.J. Smith and D. Mitchell, pp. 225-247. Canadian Museum of Civilization, Archaeological Survey of Canada, Mercury Series Paper 158.

Gould, R.A. and S. Saggers. 1985. Lithic Procurement in Central Australia: A Closer Look at Binford's Idea of Embeddedness in Archaeology. *American Antiquity* 50: 117-136.

Greenman, E.F. 1943. An Early Industry on a Raised Beach near Killarney, Ontario. *American Antiquity* 8(3): 260-265.

Greenman, E.F. 1946. The Killarney Sequence and its Old World Connections. *Papers of the Michigan Academy of Science, Arts and Letters* 32: 313-332.

Greenman, E.F. and G.M. Stanley. 1942. The Archaeology and Geology of Two Early Sites near Killarney, Ontario. *Papers of the Michigan Academy of Science, Arts and Letters* 28: 505-531.

Hammell, G.R. 1983. Trading in Metaphors: The Magic of Beads. In *Proceedings of the 1982 Glass Trade Bead Conference*, edited by C.F. Hayes III, pp. 5-28. Rochester, New York: Rochester Museum and Science Center, Rochester Museum and Science Center Research Records 16.

Hansen, G. 1984. Built-on Lands: Definition and Canadian Area Estimates. *Plans Canada* 17/4.

Higgins, E.G. 1982. *Whitefish Lake Ojibway Memories*. Cobalt, Ontario: Highway Book Shop.

Holen, S.R. 1991. Bison Hunting Territories and Lithic Acquisition among the Pawnee: An Ethnohistoric and Archaeological Study. In *Raw Material Economies among Prehistoric Hunter-Gatherers*, edited by A. Montet-White and S. Holen, pp. 399-411. Lawrence, Kansas: University of Kansas, Publications in Archaeology 19.

Ingold, T. 1992. Culture and the Perception of the Environment. In *Bush Base: Forest Farm, Culture, Environment and Development*, edited by E.Croll and D. Parkin, pp.39-56. London: Routledge.

Ingold, T. 1993. The Temporality of Landscape. *World Archaeology* 25(2): 152-174.

Jackson, L.J. and H. McKillop. 1987. Patterns in Prehistory: The Sheguiandah Site, 1952-1956. *Arch Notes: Newsletter of the Ontario Archaeological Society* 87(1): 9-15.

Jackson, L.J., H. McKillop and S. Wurtzburg. 1987. The Forgotten Beginning of Canadian Paleoindian Studies, 1933-1935. *Ontario Archaeology* 47: 5-18.

Johnson, J.K. 1984. Measuring Prehistoric Quarry Site Activity in Northeastern Mississippi. In *Prehistoric Chert Exploitation: Studies from the Midcontinent*, edited by B.M. Butler and E.E. May, pp.225-235. Carbondale, Illinois: Southern Illinois University, Center for Archaeological Investigations, Occasional Papers 2.

Julig, P.J. and P.L. Storck.1992. Survey and Re-excavation of the Sheguiandah Site. *In* Archaeological Services Inc.: Report on Phases 1 and 2 of the Archaeological Master Plan for the Township of Howland, Ojibways of Sucker Creek and the Sheguiandah First Nation, pp.30-89. Manuscript on file with the Ontario Ministry of Citizenship, Culture and Recreation, Toronto.

Kelley, J.H. and R.F. Williamson. 1996. The Positioning of Archaeology within Anthropology: A Canadian Historical Perspective. *American Antiquity* 61(1): 5-20.

Lee, T.E. 1955. The Second Sheguiandah Expedition, Manitoulin Island, Ontario. *American Antiquity* 21(1): 63-71.

Lee, T.E. 1957. The Antiquity of the Sheguiandah Site. *Canadian Field Naturalist* 71(3): 117-137.

Lee, T.E. 1959. An Archaeological Survey of Southwestern Ontario and Manitoulin Island. *Pennsylvania Archaeologist* 29(2): 80-92.

Lee, T.E. 1963. A Point Peninsula Site, Manitoulin Island, Lake Huron. *Bulletin of the Massachusetts Archaeological Society* 26(2): 19-30.

Lewis, C.F.M. 1968. Late Quaternary Events on Manitoulin Island. In *The Geology of Manitoulin Island*, edited by B.A. Liberty and F.D. Sheldon, pp.60-68. Michigan Basin Geological Society Annual Field Excursion.

Lewis, C.F.M. 1993. Interpretation Strategy for the Sheguiandah Archaeological Site: Future Use and Tourism Analysis. Manuscript on file with the Township of Howland, Ojibways of Sucker Creek and the Sheguiandah First Nation, Manitoulin Island.

Major, F.W. 1934. *Manitoulin, The Isle of the Ottawas*. Gore Bay, Ontario: The Recorder Press.

Mayer, R.G., editor. 1987. Onoyota'a:ka: People of the Standing Stone: The 1985 Archaeological Survey of the Oneida Nation of the Thames. Manuscript on file with the Ontario Ministry of Citizenship, Culture and Recreation, Toronto.

Moulton, A.L. and T.S. Abler. 1991. Lithic Beings and Lithic Technology: References from Northern Iroquoian Mythology. *Man in the Northeast* 42: 1-7.

Museum of Indian Archaeology. 1989. An Archaeological Facilities Master Plan for the Christian Island Indian Reserve. Manuscript on file with the Ontario Ministry of Citizenship, Culture and Recreation, Toronto.

Myers, F. 1969. History of the Hudson's Bay Company Post at Little Current, Ontario. *Inland Sea* 15: 88-96, 222-232, 276-282.

Nin.Da.Waab.Jig Research Centre and Cataraqui Archaeological Research Foundation. 1990. The Walpole Island Archaeological Master Plan Study. Manuscript on file with the Ontario Ministry of Citizenship, Culture and Recreation, Toronto.

Ojibwe Cultural Foundation. 1989. Oral History Project - Final Report. Manuscript. on file with the Ontario Heritage Foundation, Toronto.

Ontario Heritage Policy Review. 1990. *The Strategy for Conserving Ontario's Heritage: The Report of the Ontario Heritage Policy Review*. Toronto: Ministry of Culture and Communications.

Reher, C.A. 1991. Large Scale Lithic Quarries and Regional Transport Systems on the High Plains of Eastern Wyoming: Spanish Diggings Revisited. In *Raw Material Economies among Prehistoric Hunter-Gatherers*, edited by A. Montet-White and S. Holen, pp. 251-284. Lawrence, Kansas: University of Kansas, Publications in Archaeology 19.

Robertson, D.A., R.F. Williamson, R.I. MacDonald, R.H. Pihl and M.S. Cooper. 1997. Interpretations and Conclusions. In *In The Shadow Of The Bridge: The Archaeology Of The Peace Bridge Site (AfGr-9), 1994-1996 Investigations,* edited by R.F. Williamson and R.I. MacDonald, pp. 493-510. Toronto: Archaeological Services Inc., Occasional Publications of Archaeological Services Inc. 1.

Rogers, E. S. 1978. Southeastern Ojibwa. In *Handbook of North American Indians, Volume 15: The Northeast*, edited by B.G. Trigger, pp. 760-771. Washington, D.C.: Smithsonian Institution Press.

Sanford, J.T. 1957. Geologic Observations at the Sheguiandah Site. *Canadian Field Naturalist* 71(3): 138-148.

Schmalz, P. 1991. *The Ojibway of Southern Ontario.* Toronto: University of Toronto Press.

Storck, P.L. 1997. *The Fisher Site: Archaeological, Geological and Paleobotanical Studies at an Early Paleoindian Site in Southern Ontario, Canada.* Ann Arbor: University of Michigan, Memoirs of the Museum of Anthropology, 30.

Surtees, R.J. 1969. The Development of an Indian Reserve Policy in Canada. *Ontario History* 62: 87-98.

Tilley, C. 1994. *A Phenomenology of Landscape: Places Paths and Monuments*. Providence, Rhode Island: Berg.

Thomas, J. 1993. The Politics of Vision and the Archaeologies of Landscape. In *Landscape: Politics and Perspectives*, edited by B. Bender, pp. 19-48. Providence, Rhode Island: Berg.

Thomas, S.C. 1992. Analysis of Faunal Sample from Lower Surface Scatter near North 1-East 320, Sheguiandah Site. *In* Archaeological Services Inc.: Report on Phases 1 and 2 of the Archaeological Master Plan for the Township of Howland, Ojibways of Sucker Creek and the Sheguiandah First Nation, pp.191-194. Manuscript on file with the Ontario Ministry of Citizenship, Culture and Recreation, Toronto.

Trigger, B. G. 1989. Archaeology and Anthropology: Current and Future Relations. *Canadian Journal of Archaeology* 13: 1-12.

Wightman, W.R. 1982. *Forever on the Fringe: Six Studies in the Development of Manitoulin Island.* Toronto: University of Toronto Press.

Williamson, R.F. 1996. Sacred Stone: The Archaeology of Caches. Paper presented at the 23rd Annual Symposium of the Ontario Archaeological Society, Kingston Ontario. Manuscript on file with Archaeological Services Inc., Toronto.

Chapter 4

Geoarchaeological Studies of the Sheguiandah Site and Analysis of Museum Collections

Patrick J. Julig and William C. Mahaney

Abstract

A selected portion of the Sheguiandah site collections excavated by T. E. Lee were analyzed in 1989 and 1990, including both artifacts and sediment samples. The results of these and the subsequent archaeological and sedimentological studies are presented. The sediment analyses indicated a range of depositional processes, and these results assisted with planning of subsequent research field methodologies to resolve the origin of the controversial "till-like" deposits. These "till like" deposits with artifacts were found to lack key characteristics of glacial till. Artifact studies indicate long-term use of the site from Paleoindian to Woodland period, with predominately Late Paleoindian (Plano) and Archaic occupations in the Habitation Area. AMS ^{14}C dates (ca. 9500 to 7000 BP) indicate that early pre-ceramic use of the site may have exceeded 2500 years, with occasional use in subsequent times. The quartzite industry in the Habitation Area shows close similarities to other upper Great Lakes Plano quarry/habitation sites. Artifact refit studies assisted in determining post-depositional site formation processes. The presence of water polished artifacts indicates contemporaneity of initial site occupation with active beach environments, either around the time of the Korah phase of Lake Algonquin or before the Early Mattawa flood event ca. 9600 BP.

Résumé

Une partie choisie des collections extraites du site de Sheguiandah par T. E. Lee a été analysée en 1989 et 1990, y compris des échantillons d'artefacts et de sédiments. L'auteurs présentent ici les résultats de ces études archéologiques et des sédiments. Les analyses des sédiments révèlent une gamme de processus de déposition; ces résultats ont aidé à planifier les méthodes de recherche subséquente sur le terrain afin de trouver l'origine des dépôts controversés ressemblant à du till. Les formations meubles de type till contenant des artefacts ne montrent aucune caractéristiques propres aux sédiments glaciaires. Les études des artefacts révèlent que le site a été utilisé pendant une longue période, de la période paléoindienne à la période du sylvicole, et que la zone d'habitation a surtout été occupée à la fin de la période paléoindienne (Plano) à la période archaïque. La datation au carbone 14 par SMA (9,5 à 7,0 ka) indique que le site a été occupé tout d'abord avant la culture de la céramique pendant peut-être plus de 2 500 ans, et qu'il a par la suite été occupé à l'occasion. L'exploitation du quartzite dans la zone d'habitation affiche de grandes similitudes avec celles d'autres sites d'habitation et de carrières de la fin de la culture Plano dans la région supérieure des Grands Lacs. Des études de remontage des artefacts ont aidé à déterminer les processus de formation du site après les dépôts. La présence d'artefacts polis par l'eau indique que le site a été occupé à l'époque où les

The Sheguiandah Site: archaeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario, edited by P. Julig. Canadian Museum of Civilization, Archaeological Survey of Canada, Mercury Series Paper 161, 2002.

environnements riverains étaient actifs, soit à la phase Korah du lac Algonquin ou lors de l'inondation de la période Mattawa ancienne, il y a environ 9,6 milliers d'années.

Introduction

Paleoenvironmental studies are often conducted as a normal part of archaeological research programs, and for late Pleistocene/Early Holocene sites with complex stratigraphic and contextual issues, a geoarchaeological approach is important. However, for some archaeological projects, these studies are much more fundamental – indeed mandatory - for determining the actual context of the artifact material within the sedimentary matrix (see Stein and Farrand 1985; Julig *et al.* 1990, Julig *et al.* 1994b). The Sheguiandah site on Manitoulin Island (BlHl-2) is a case in point. Discovered and excavated in the early 1950s by Thomas Lee of the National Museum of Man, the Sheguiandah site was claimed to contain artifacts in glacial till, and thus was argued to document a pre-Clovis human occupation of the New World (Lee 1957). The lack of a final excavation report on the site, and the continuing controversy over the precise timing of human occupations in the New World, have caused the Sheguiandah site to remain ambiguous and in need of resolution.

In 1989, the senior author started re-investigations of the Sheguiandah site by analysis of collections excavated by Lee (1953, 1954, 1955), including both the sediments from certain excavated sections and test pits, and the artifact collections, curated at the Canadian Museum of Civilization (Julig *et al.* 1994a, 1994b). While the analyses of the collections were in progress, some new sampling work and testing (coring) began on the site in 1990 (Julig and Storck, this volume), in order to obtain new samples for AMS radiocarbon dating. This was followed in 1991 by an archaeological master plan under the overall direction of Archaeological Services Inc., from Toronto (ASI 1992).

The objectives of the master plan included resolution of the questions of the site's antiquity and origin of the controversial mixed "till-like" deposits in the Habitation Area. Because of the in-progress Sheguiandah collections research, Julig was asked to join the ASI team to plan these new geoarchaeological studies. The necessity of a multi-disciplinary approach was clearly evident (see Julig and Storck, this volume, also Julig *et al.* 1994b), and the analysis of the existing collections and artifact taphonomy (refit studies of conjoining artifacts and water-worn artifacts) provided important evidence about site-formation. Two approaches were used in re-opening investigations at the Sheguiandah site. These involved: 1) an analysis (or re-analysis) of selected artifacts and soil/sediment samples obtained by Lee, as well as 2) limited re-excavations and re-sampling in 1991 of selected squares/trenches opened by Lee during field work in the early 1950's.

This chapter will first discuss how collections analyses assisted in the application of a coordinated geoarchaeological research approach. These analyses helped to clarify the issues, present testable hypothesis, and select methodologies to answer outstanding questions of the age and cultural affinity of the reported artifacts in the "till-like" mixed deposits or diamictons. Data on the sedimentology of the 1950's sediment sample collections are presented, with comparisons to the analyses of 1991 collected samples from the same locations. Both suites of samples were analysed at the Geomorphology and Pedology Lab at York University for granulometry, mineralogy, and SEM studies.

Archaeological data are then presented in the second part of this chapter, for the Lee collections, as well as limited summary data on the 1991 excavations. A comprehensive technological analysis was not completed for the Lee collections because the artifacts 1) have only a field catalogue, 2) are widely dispersed to numerous institutions, and 3) are not a systematic nor representative collection (few cores and flakes were retained, but many bifaces were surface collected, see R. Lee, this volume). However analyses of all the available projectile points collection was completed in a separate chapter (Storck, this volume). We also present in Part II of this paper, a selection of representative biface and uniface tool types in the Sheguiandah collections, typical of the late Paleoindian Plano period in the Great Lakes region.

The third Part of this chapter reviews the 1991 re-investigations and reports the results on the new sediment sample analysis, the ^{14}C dates, and other data on context. The 1991 re-excavations were primarily to obtain geoarchaeological data, not new artifact collections from the Habitation Area. The previously excavated "stations" 7-8 and 7-9 and test-pits from Lee's 1950's work were re-opened, the section faces excavated back to fresh material, and the stratigraphy sampled and analyzed (Julig *et al.* 1991; Julig *et al.* 1994b). The depth and context of *in situ* cultural materials at the various locations and from Swamps 3 and 4, and associated AMS ^{14}C dates are reported. Both the previous collections analysis and new geoarchaeological and archaeological analysis contributes to understanding the age, environmental setting, and purpose of human occupation at the Sheguiandah site.

Studies of T. Lee's Geological and Archaeological Samples

From 1989 to 1990, we analyzed existing samples of archaeological and geological material obtained by Lee nearly 40 years previously. Objectives of this research were to: 1) examine selected artifacts from various levels in the site, particularly controversial Levels III and IV in the so-called "till" units, for evidence of differences in lithic technology that might support the cultural stratigraphy as interpreted by Lee; 2) examine characteristics of the sediments to determine their possible origin and environments of deposition; 3) tabulate the number and locational context of portions of conjoined artifacts to determine the extent of post-depositional mixing in the sediments; and, 4) obtain charcoal or other organic material collected by T. Lee for AMS radiocarbon dating.

In the following discussion for both the previous Lee excavations and collections, and recent 1991 field work, we will refer to various parts of the site using the names applied by Lee. These names/areas include: the Habitation Area, the Mid-Quarry Ridge (MQR), the Hillside Dump (HD), Swamps 1-4, and the Mystic Ridge (Figure 4.1). The generalized stratigraphy of unconsolidated sediments of the site (Sanford, 1957, 1971) is shown on Figure 4.2, including the controversial Habitation Area strata III and IV and of Swamp 3 (see also R. Lee, this volume).

We first present analysis of the Lee collected geological sediments from the "Habitation Area" enigmatic "till-like" diamictons. The stratigraphic sections have previously been shown in Julig *et al.*1994b, and were also made available for Barnett (this volume).

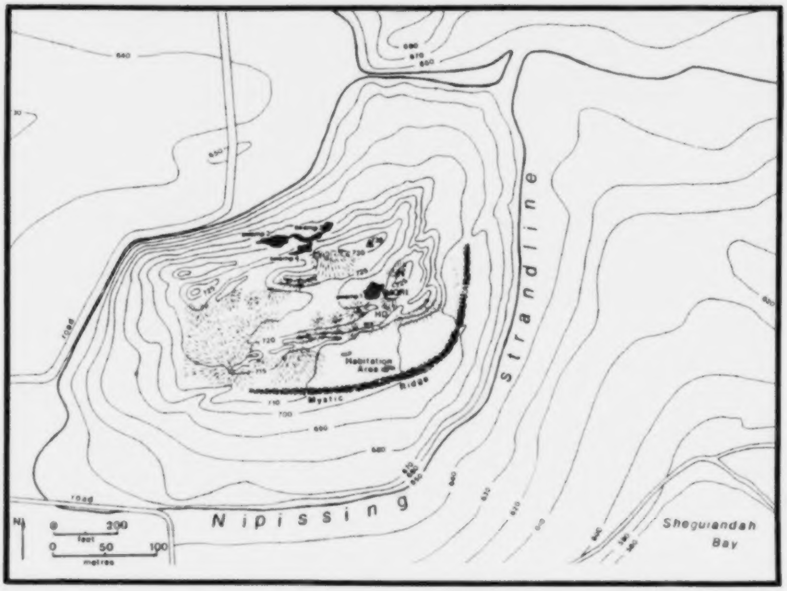

road
road
Habitation Area
Mystic Ridge
Nipissing Strandline
Sheguiandah Bay
HQ
720
725
715
710
700
680
660
640
N
0 200 feet
0 50 100 metres

Figure 4.1. Map of the Sheguiandah archaeological site, showing locations mentioned in text. Elevations are shown in feet above sea level (modified from T. Lee 1957).

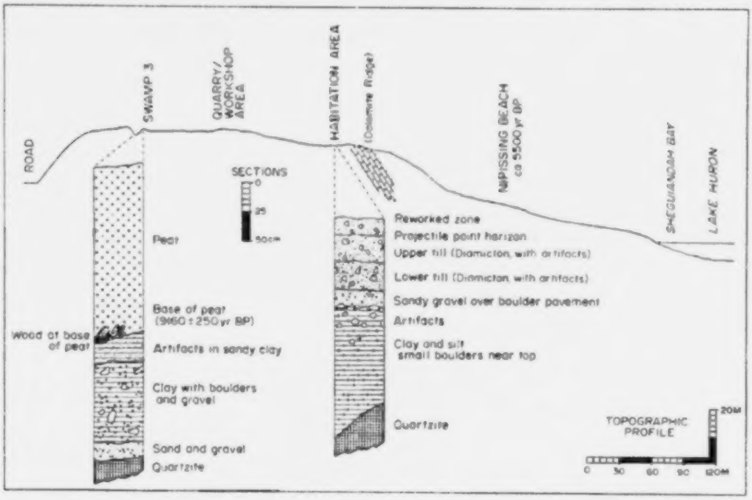

ROAD
SWAMP 3
QUARRY/ WORKSHOP AREA
HABITATION AREA
(Dolomite Ridge)
NIPISSING BEACH ca 5500 yr BP
SHEGUIANDAH BAY
LAKE HURON
SECTIONS
0
25
50cm
Peat
Base of peat (9160 ± 250 yr BP)
Wood at base of peat
Artifacts in sandy clay
Clay with boulders and gravel
Sand and gravel
Quartzite
Reworked zone
Projectile point horizon
Upper till (Diamicton, with artifacts)
Lower till (Diamicton with artifacts)
Sandy gravel over boulder pavement
Artifacts
Clay and silt small boulders near top
Quartzite
TOPOGRAPHIC PROFILE
20M
0
30
60
90
120M

Figure 4.2. Topographic profile of the Sheguiandah archaeological site, showing stratigraphic sections of the Habitation Area and Swamp 3 (modified from Sanford 1971)

Sedimentological Analysis of Lee samples, Levels III and IV

As mentioned earlier, the controversial strata at Sheguiandah are the two units described by Lee as "tills" in Levels III and IV, which contained artifacts. These deposits, also referred to as diamictons (Flint 1971; Dreimanis 1989), occur in the Habitation Area of the site (Figure 4.2) at a depth of between approximately 15 and 60 cm below ground surface. Bulk samples from these Levels III and IV, and other strata excavated by Lee, were made available to the senior author for study by the Canadian Museum of Civilization. In conjunction with William Mahaney, with funding from the Ontario Heritage Foundation, these samples were subjected to particle size analysis for the <2mm size fraction. In addition, sub-samples of fine and very fine quartz sand grains from these bulk samples were examined by scanning electron microscopy (SEM) to study their surface characteristics to obtain information about the depositional environment, particularly looking for glacial crushing features. (Krinsley and Doornkamp 1973).

Particle Size Analysis

Particle size ratios of the <2.0 mm fraction for the Lee samples were analyzed using standard screening and sedimentation methods (see Julig 1994). We determine if the sediment samples collected by Lee were characterized by relatively linear particle size curves (non-sorted, or diamictons), lacking sizeable percentages of particular sediment fractions. Such profiles may suggest a glacial and/or colluvial genesis or some other depositional history that lead to mixed rather than sorted sediments. Of the 27 samples analyzed from four areas of the site (Habitation

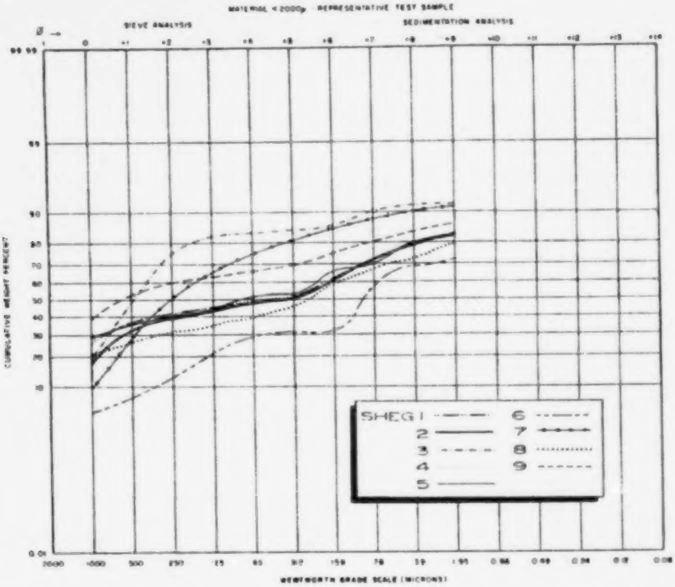


Figure 4.3. Cumulative grain-size curves of Habitation Area sediment samples, taken by T. Lee. See Table 4.1 for details on locations and depths of the samples.

Table 4.1. Grain-size data, Sheguiandah Site, T. Lee samples.

Sample	**Cat #**	**Station**	**Depth (cm)**	**Sand (2mm-63µm) (%)**	**Silt (63- 2µm) (%)**	**Clay (< 2µm) (%)**
Habitation Area						
1	997	7-1	19	48.2	34.2	17.6
2	1098	7-2	41-43	47.1	35.6	17.3
3	1238	7-2	61	84.4	8.3	7.3
4	543	7-3	15	48.8	34.9	16.3
5	443	7-4	25-28	52.4	30.0	17.6
6	444	7-4	25-28	29.3	52.9	17.8
7	373	7-4	18	74.7	16.8	8.5
8	525	7-5	16-18	39.5	39.8	20.7
9	631	7-5	40-42	66.7	19.5	13.8
7-8 Profile						
10	1261A	7-8	0-5	41.8	39.8	18.4
11	1261	7-8	10-22	43.0	40.4	16.6
12	1261B	7-8	30	53.8	29.1	17.1
13	1255	7-8	28-33	53.8	30.2	15.0
14	1261C	7-8	66	86.1	6.7	7.2
15	1261D	7-8	76	46.0	39.7	14.3
16	1261E	7-8	112	46.5	32.4	21.1
17	1261F	7-8	183	54.1	41.1	4.8
Hillside Dump						
18	491	HD-3	74-76	29.5	42.4	28.1
19	492	HD-3	89-94	47.6	41.9	10.5
20	493	HD-3	122-124	52.0	38.2	11.8
Swamp 1 TP-1						
21	1196	SA-1/TP1	36	5.7	62.4	31.9
22	1198	SA-1/TP1	46	8.3	72.4	19.3
Mid-Quarry Ridge (MQR)						
23	1748	TT-1	43	44.1	39.6	16.3
24	1747	TT-1	51	74.7	12.6	12.7
25	1747A	TT-1	66	67.6	2.4	30.0
Swamp 1						
26	1263	SA-1	30-36	8.8	75.2	16.0
27	1264	SA-1	46-51	33.0	49.4	17.6

Area, Hillside Dump, Swamp 1, and the Mid-Quarry Ridge trench), 19 samples exhibit fairly linear "curves" or profiles which are characteristic of non-sorted "diamicton-like" sediments, such as till or colluvium (see Julig *et al.* 1994b, Figures 14.2-14.6). The grain size curves for nine of these Lee samples from the Habitation Area Samples are shown on Figure 4.3, and percentage data from all 27 samples, from site locations, in Table 4.1. A stratum of sandy gravel underlying the diamicton in stratigraphic Levels III and IV and overlying a boulder pavement (e.g. Samples 3 and 14; Table 4.1) are sorted (mostly sand) and probably of lacustrine origin. However, most of the sediment samples between the surface and a depth of about 50-60 cm in the Habitation Area, the Hillside Dump, and the Mid-Quarry Ridge exhibit fairly linear grain-size profiles, indicating they are not sorted. These samples are however from the A and B soil horizons and the mixing may be the result of pedogenic and/or freeze thaw processes, and linear cumulative grain-size profiles do not necessarily prove they are "tills".

The excavation profile of Station 7-8 from the 1991 excavations, (discussed in Part III) showed that the "B" soil horizons in the Habitation area extends to about 50 cm depth and that pedogenic (soil formation, bioturbation, freeze-thaw) activities could contribute to the mixing. However, below 50 to 60 cm the sediments are typically sorted beach sands with some boulders (see also Barnett, this volume). The grain size curves and percentages for the Lee samples from Station 7-8 (Figure 4.4 and Table 4.1) as an example, with SHEG sample 14 being mostly (86%) sorted sand.

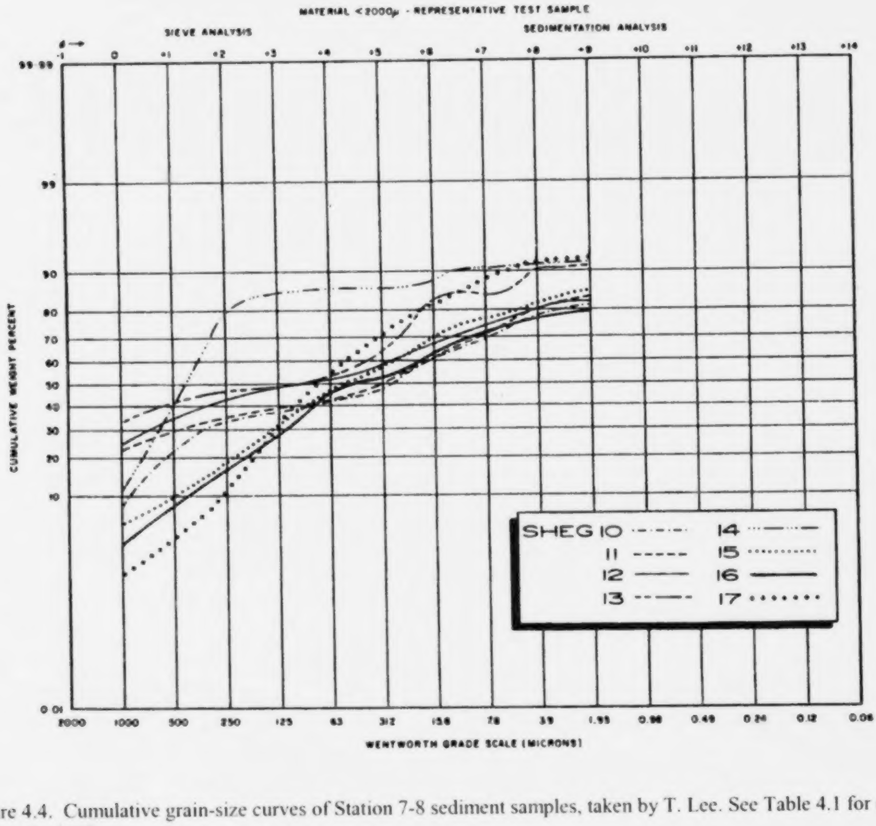


Figure 4.4. Cumulative grain-size curves of Station 7-8 sediment samples, taken by T. Lee. See Table 4.1 for details on sample depths.

The general pattern from analysis of the Lee samples is for mixed sediments nearer the surface, and sandy sorted sediments below approximately 50 - 60 cm depth (e.g. Figure 4.5, MQR samples). From these analyses of the Lee samples we determined that most of the samples from the upper part of the soil profiles, above about 60 cm, in the Habitation Area, Hillside Dump, and the Mid-Quarry Ridge (Figure 4.1) have fairly "linear" grain-size profiles, and are typically "mixed" deposits as reported by Lee and Sanford. However, this does not necessarily imply that these B horizon soil profiles are "tills", rather the glacial till is below the boulder sand, as discussed in Part III.

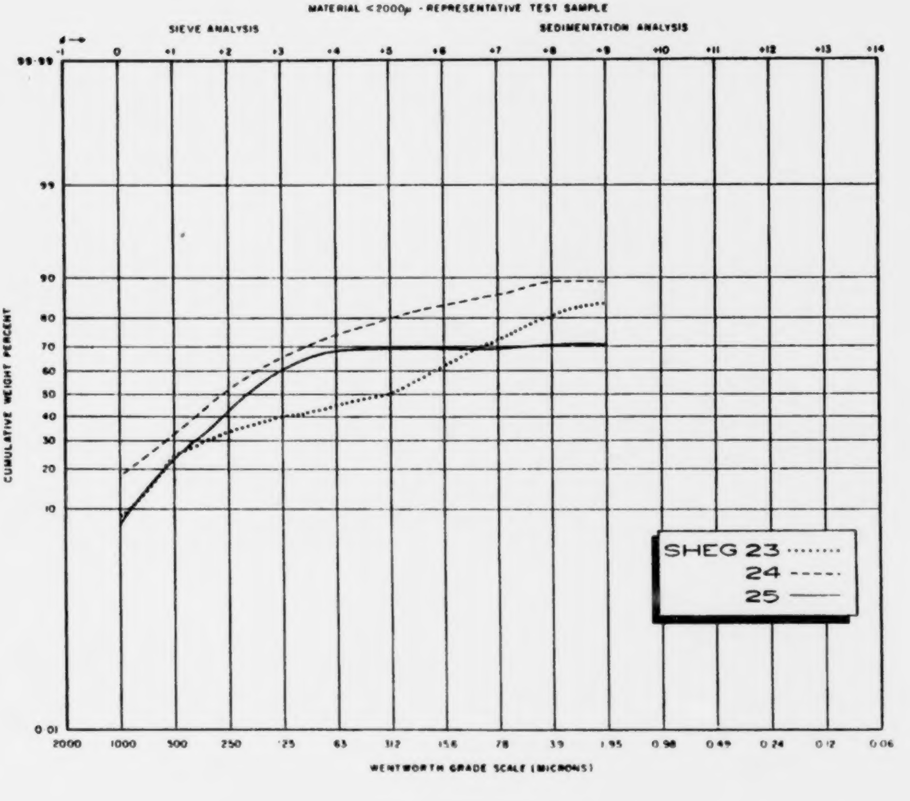


Figure 4.5. Cumulative grain-size curves for sediment samples taken by T. Lee from the Mid-Quarry Ridge trench, Sheguiandah site (BIHI-2), Manitoulin Island.

Scanning Electron Microscopy

Quartz grains from the fine and very fine sand fractions (63-250 µm) from the diamictons in stratigraphic Levels III and IV were analyzed to determine their surface characteristics. They exhibited chemically weathered fractures and surfaces indicating that they were derived from older deposits, and/or from reworking during higher lake Algonquin levels (see Figure 14.7 in Julig *et al.* 1994b). No evidence of fresh unweathered glacial crushing (fracturing) or abrasion was observed on any of the grains studied, which would be expected on quartz grains in till.

Crescentic gouges (Krinsley and Doornkamp 1973), which are widely considered to be the result of transport by glacial ice, were observed on grains from several samples (see Figure 14.7F in Julig *et al.* 1994b), but these grains are also heavily weathered. Other grains, exhibiting deep-furrow features presumably originating from transport in continental glaciers, also exhibit weathering effects, mainly as dissolution etching (Mahaney *et al.* 1988). Finally, some quartz grains from the upper diamicton (Level III) exhibit sawtooth fracture patterns (see Figure 14.7C in Julig *et al.* 1994b) that have been observed on sub-aqueous marine debris flow deposits (Mahaney, unpublished). Their surface textures suggest that Level III and IV sediments are re-worked by water, rather than being primary glacial till, as fresh glacial crushing would be present (Julig *et al.* 1990)

Overview of Lee's Sediment Samples

Analysis of the fine fraction of sediment samples collected by Lee (see Barnett, this volume for coarser fraction data) indicate that the stratigraphic units that he and Sanford interpreted to be "till" do in fact have some characteristics of till (i.e. mixed particle size and some quartz grains with surface textures characteristic of erosion by glacial ice). However, our analyses also indicate that the sediments have features which are the result of secondary transport (i.e. rounded quartz grains exhibiting no evidence of fresh crushing) suggesting that the sediments were not deposited directly by glacial ice but were re-worked by lacustrine and/or pedogenic geomorphic agent/agents. As suggested by Barnett (this volume), mixing could have occurred during the Korah phase, or Early Mattawa flood event (Anderson and Lewis, this volume). Our analysis of the Lee samples indicate that sediments in Levels III and IV Habitation Area are diamictons, but also suggest, contrary to Sanford and Lee's interpretation, that the sediments are probably not of glacial origin, but mixed by other geomorphic agents. We explore this further and present evidence in Parts II and III (see also Barnett, this volume).

Analysis of Artifacts from Lee Collections

In 1989, with funding from the Social Sciences and Humanities Research Council of Canada (SSHRCC), Julig initiated a re-analysis of selected artifacts housed in the Canadian Museum of Civilization which Thomas Lee obtained in the early 1950s during his excavations at Sheguiandah. The objectives of the research were to: 1) analyze a sample of the artifacts from the various levels in the Habitation Area for evidence of differences in lithic technology that might support the cultural stratigraphy as interpreted by Lee (1957); 2) tabulate the number and context (location) of conjoined artifacts in order to determine the extent of post-depositional mixing in the site sediments; 3) carry out experimental use-wear studies on Sheguiandah quartzite artifacts to determine what materials they were used to work, and 4) obtain charcoal samples from for radiocarbon dating, particularly from the lower stratigraphic levels and the mixed deposits (diamictons) with artifacts.

In 1990, with funding from the Ontario Heritage Foundation, Julig initiated AMS radiocarbon dating of small organic samples form Sheguiandah and, in conjunction with W.C. Mahaney (York University) and R. Buekens, Isotrace Laboratory, University of Toronto.

Significant progress was made on objectives 1, 2, and 4 prior to the commencement of the 1991 Master Plan study (see Robertson *et al.* this volume). Objective 3, the use-wear study, was conducted at Laurentian University, using the facilities in the Archaeology Laboratory and the scanning electron microscope (SEM) in the Geology Department. We will review below the major results of these studies, in the chronological order in which they were carried out, but will not report on the SEM use-wear study here (Julig, unpublished).

Technological Studies

During a two week period in December 1989, and January 1990, the Sheguiandah collections were examined by P. Julig at the Canadian Museum of Civilization in Hull. Of the many thousands of specimens, approximately 400, representing four classes of artifacts (bifaces, unifaces, cores, and platform flakes) were selected from the four main cultural levels of the Habitation Area (Levels II to V).

The lithic analyses involved the recording of approximately 20 observations and measurements (attributes) on each specimen, using low-powered microscopy and various measuring devices. The technological analysis methodology is similar to that published in Julig (1994) on the Cummins Late-Paleoindian quarry-workshop site. The available sample sizes for certain classes of artifacts (bifaces and cores) were rather small, particularly for the controversial cultural levels IV and V. Also, Lee did not retain all debitage (flakes) and cores. Despite these limitations, some interesting information was obtained which is briefly summarized below.

Lee (1957) reported large, thin bifaces in the "upper till" (Cultural Level IV) and smaller, thicker bifaces in the "lower till" (Cultural Level V). The results of mean widths and mean width to thickness ratios for a combined sample of the upper levels (II, III, and IV) versus the "lower till" (Level V) bifaces for five stations in the Habitation Area are shown in Table 4.2.

Data in Table 4.2 indicate that the bifaces in the combined upper Levels (II-IV) are wider (67.7 vs. 56.3 mm) and have larger mean width/thickness ratios than those in Level V. The sample size (12) from Level V is small and many specimens are incomplete, but it appears that Lee may be correct in his statement about differences in biface morphology between the lower and upper (cultural?) levels. However, it is not yet certain what factors are responsible for this distribution, and post-depositional factors may be important in this regard. The upper level bifaces are often late stage preforms (Figure 4.6), while biface cores may be more common in Level V. Also, differential frost heave may affect the larger bifaces relative to the smaller bifaces and move them up in the sedimentary profile (Julig, 1994). However, this observation by Lee needs to be tested in future excavations.

Table 4.2. Comparison of Sheguiandah Habitation Area Biface Samples.

Level	Number	Mean Width (mm)	Mean Width/ Thickness Ratios (mm)
II to IV	73	67.7	3.93
V	12	56.3	3.22

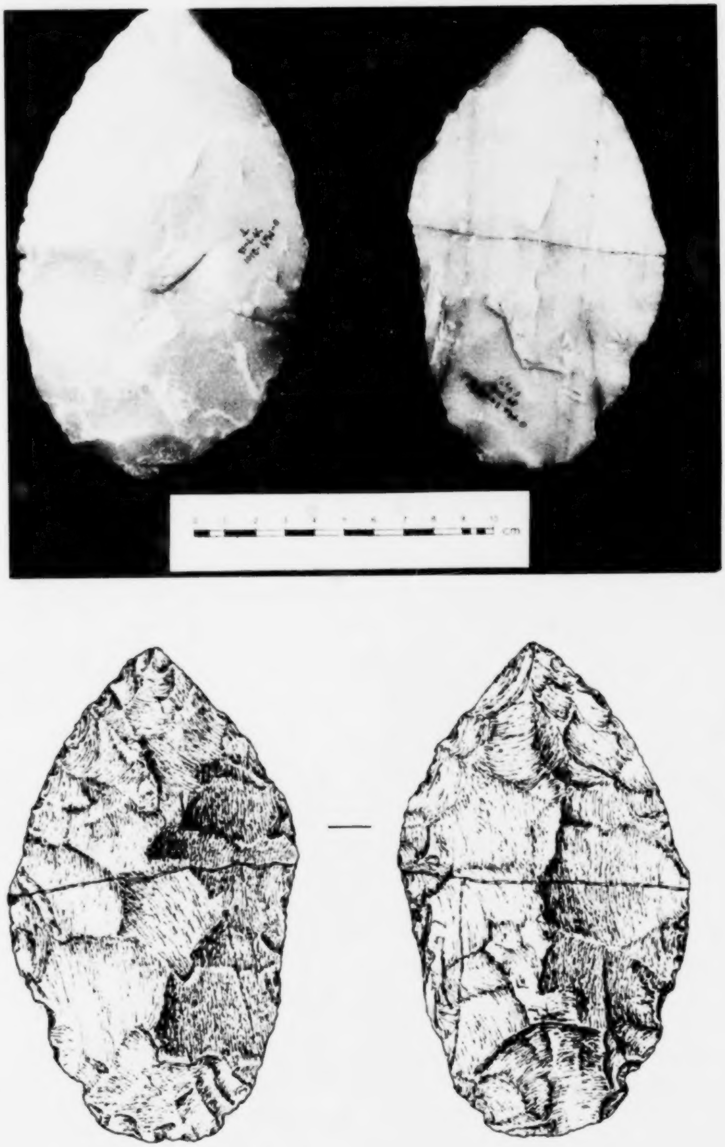


Figure 4.6. Broken late stage biface preforms, refits.
Top: Left, O-MAv1-1421.1 / St. 7-9, depth 5.7-7cm; O-MAv1-1558.1/ St. 7-9, depth 14.6 cm
Right, O-MAv1-2114 / St. 7-12, (transitional); O-MAv1-2101, St. 7-12, (transitional)
Illustration: O-MAv1-2114 / St. 7-12, (transitional); O-MAv1-2101, St. 7-12, (transitional)

Most of the bifaces examined are preforms (Figure 4.6), or late - stage biface knives or spear points (Figure 4.7). Some bifaces and flakes were abraded or worn over all surfaces, probably by water (Figure 4.8) and will be discussed further below.

Some unusual "invasive" flaking patterns were also observed on bifaces from the lower levels. This flaking pattern is not commonly reported in Late Paleoindian assemblages. Also, several bifaces exhibit flake removal scars that extend nearly across their surfaces (Figure 4.9) similar to observations on earlier Paleoindian (Clovis) technology.

Many broken bifaces show evidence of re-use and some were re-sharpened (Figure 4.10, top). This is appears a common pattern on other Paleoindian quarry-workshop habitation sites (Julig, 1994). Not all bifaces are on quartzite, for example some drills are chert (Figure 4.11).

The unifacial flake tools assemblage, including the end and sidescrapers, are similar in variety and form (Figures 4.12) to those commonly recovered on other Late Paleoindian sites (Julig, 1994), including denticulate and notched forms (Figure 4.13a, b).

Lee (1957) reported macroblade cores and macroblades in the Sheguiandah quartzite industry. Occasional use of macroblades has been reported on several other Paleoindian sites in western North America and the Great Lakes region (Julig, 1994). Our analysis did not reveal any true (prismatic) blades, but instead blade-like macro and microblade flakes. Seven of the 44 cores examined exhibited blade-like flake removal scars. These parallel flaked cores occurred in greater percentages in Level V (four of eight, or 50%); however, it is unclear whether Lee retained a representative sample of cores. Examples of blade-like flakes (Figure 4.14) occur in all levels of the Habitation Area, and the Hillside Dump (Figure 4.1).

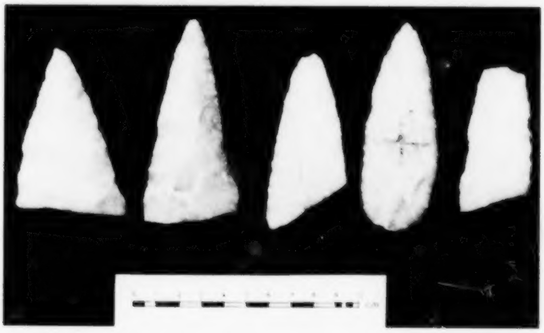


Figure 4.7. Late-stage bifaces and point preforms.
Left to Right: O-MAv1-1514.1, St. 7-9, depth 12 cm; O-MAv1-1483.1, St. 7-9, depth 10cm;
O-MAv1-1529, St. 7-9, depth 13 cm; O-MAv1-976, St. 7-2, depth 18cm; fits with
O-MAv1-886, St. 7-2, depth 11cm; O-MAv1-1622, Mrs. Trott's Garden.

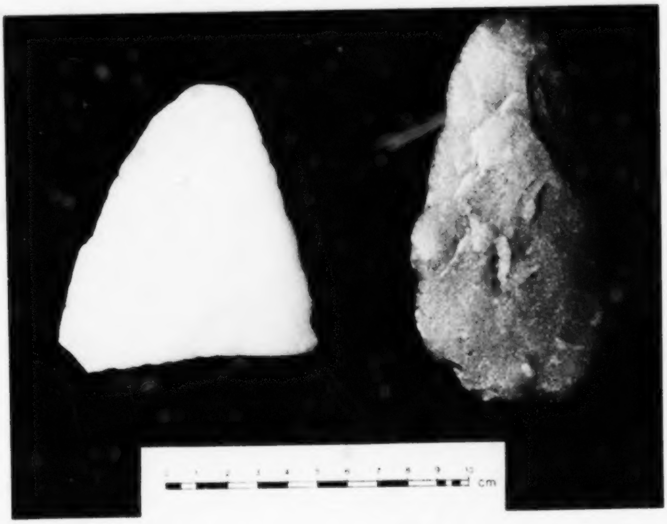


Figure 4.8. Water polished bifaces.
Left: O-MAv1-2028, St. 7-11, Humus (also water polished along break)
Right: O-MAv1-235.1, St. 7-4, depth 5cm

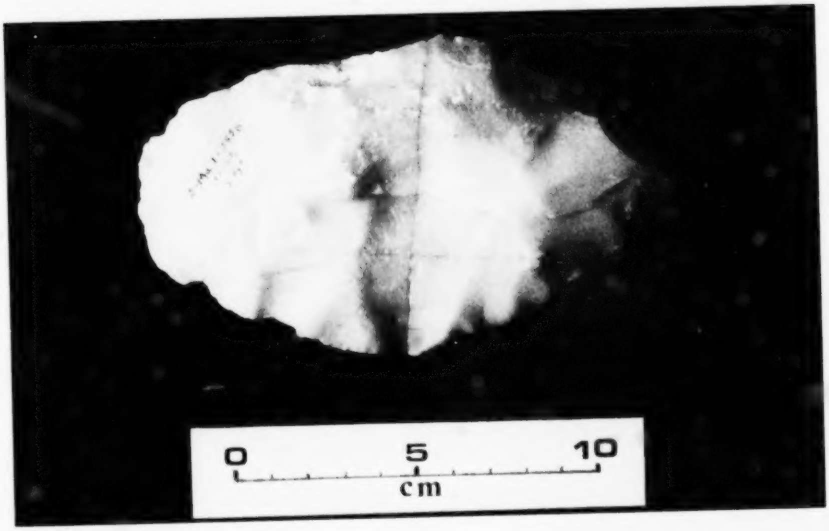


Figure 4.9. Large biface, refit, with broad facial flaking; O-MAv1- 1588.

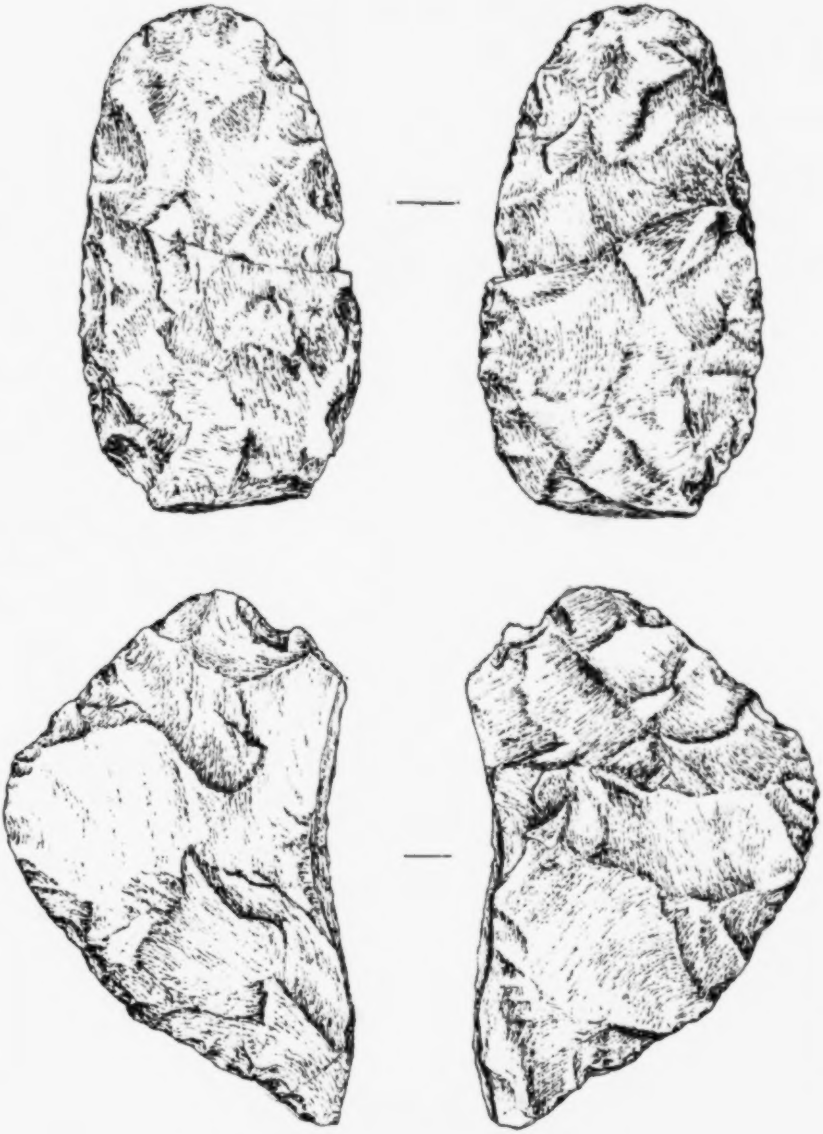


Figure 4.10. Used biface fragments (no scale available).
Top: O-MAv1-165.2, St. 7-3; fits with, O-MAv1-98.2, St. 7-3
Bottom: O-MAv1-326.1.b, St. 7-5, depth 12.5cm

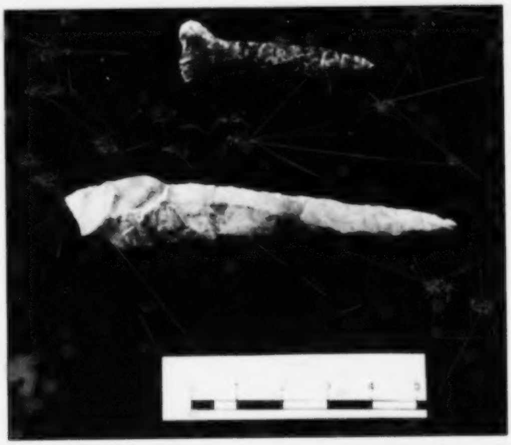


Figure 4.11. Chert drills.
Top: O-Mav1-588, T-drill, Upper till (U.T.)
Bottom: O-MAv1-368, St. 7-5, depth 9cm; fits with, O-MAv1-1097, St. 7-7, depth 20cm

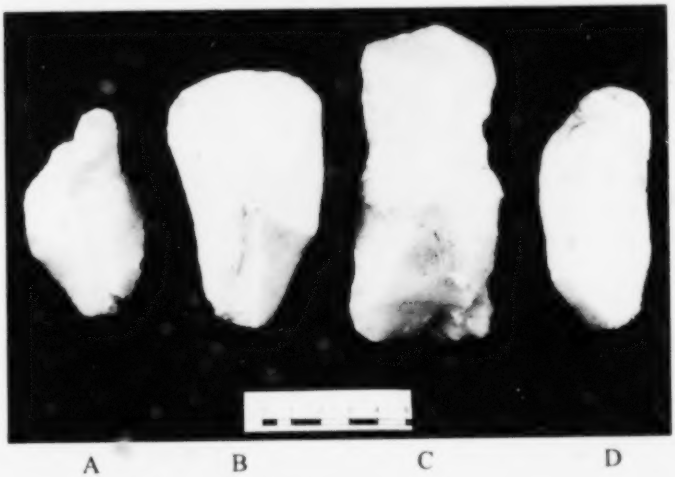


Figure 4.12. Uniface end and side scrapers.
A) O-MAv1-613.1-2, St. 7-5, End scraper, depth 22 cm
B) O-MAv1-634.1, St. 7-5, End scraper, depth 43 cm (pit)
C) O-MAv1-182.2, St. 7-3, Side scraper, depth 13cm
D) O-MAv1-868.2-1, St. 7-1, Side scraper, depth 5cm

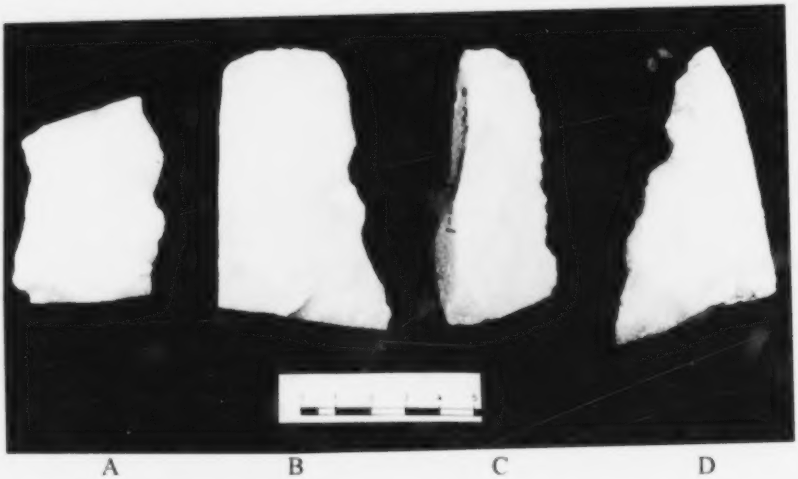


Figure 4.13a. Denticulate and notched unifaces.
A) O-MAv1-260.2, St. 7-5, depth 10cm
B) O-MAv1-1612.1, St. 7-9, depth 19cm
C) O-MAv1-982.1, St. 7-1, depth 19cm
D) O-MAv1-868-2.3, St. 7-1, depth 5cm

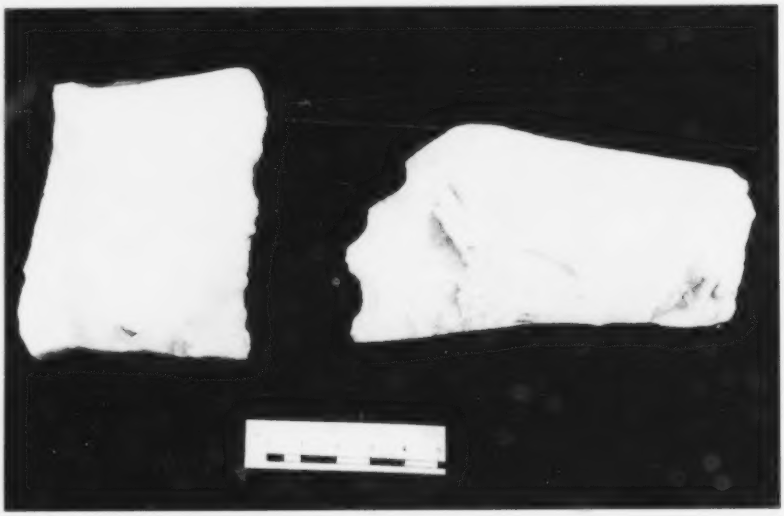
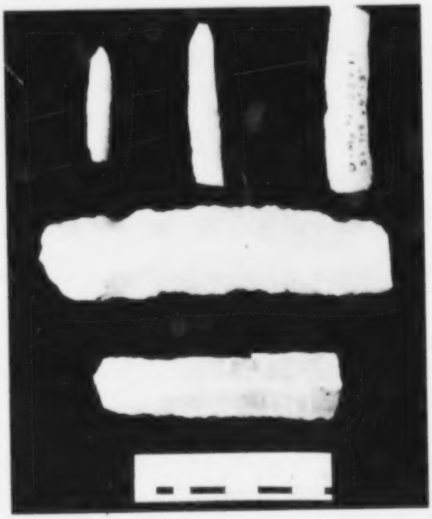


Figure 4.13b. Large denticulate and notched unifaces.
Left: O-MAv1-514.2, St. 7-5, Denticulate side scraper, depth 16cm
Right: O-MAv1-2041-2.1, St. 7-11, Notched end scraper, in "till"



Fgure 4.14. Microblade (top) and macroblade-like flakes (bottom).
Top row: O-MAv1-280, St. 7-2, depth 7cm; O-MAv1-17-53A, St. 7-9, depth 9cm; O-MAv1-334-1.2, St. 7-4, depth 17cm
Middle: O-MAv1-517, Hillside Dump, 45-60cm
Bottom: O-MAv1-517, Hillside Dump, 45-60cm; refits with, O-MAv1-517
(O-MAv1-517 was flake batch number, all in same place)

Interesting technological patterns are evident, as noted in this brief overview of the artifact analysis, some of which may warrant further study. However, this will require new excavations with representative recovery of all artifactual material. There appears to be evidence for some technological change from the Lower to the Upper levels, with respect both to biface and unifacial tool manufacturing patterns. However, it may be difficult to clarify these relationships by studying only the Habitation Area assemblages, since evidence from conjoined artifact pieces indicates these assemblages are partly mixed (see below). To more fully document technological change in this quartzite industry may require discrete (unmixed) assemblages for analysis.

Conjoined Artifacts

During his analysis of the excavated material, Lee refitted biface fragments obtained from various strata in the Habitation Area, and refits were made in our study. Examining these refitted artifacts with respect to the excavated context (location) of the separate fragments indicates that considerable mixing has occurred throughout the stratigraphic profile at the Habitation Area (Table 4.3). Not all specimens could be placed in Lee's levels, as some fragments lacked depths.

Of the 24 refitted specimens, less than half had minimal vertical displacement, that is, with all part of the specimen occurring within the same stratigraphic level. Most refits had vertical displacements of at least one stratigraphic level; that is, crossing one of Lee's stratigraphic boundaries. However, several specimens recovered on or near the surface were refitted with fragments from Levels II or III, in the upper diamicton (mixed deposit). In one instance a biface fragment from the surface (level I) conjoined with the other half from a depth of 66.0 cm, crossing four stratigraphic boundaries. Also, the projectile points (Storck, this volume), occur between one and 10 inches of the surface (0 - 25 cm), spanning levels II and III, not only in level III, as reported by Lee (1957). The data in Table 4.3 indicates that considerable post-depositional mixing, probably originating from processes such as tree falls, down slope movement, and possible frost heave, has significantly affected artifact context in the Habitation Area. The sediments and artifacts were mixed after the artifacts broke and entered the archaeological record. We have observed tree-throws in the Habitation Area, and the southeast to southwest high topographic exposure, and shallow bedrock would lead to trees blowing over.

Recent Re-Excavations in 1990/91 and Analysis

The Sheguiandah·site is designated under the Ontario Heritage Act (Part VI., Sec 48 and 56) and archaeological investigations, indeed any proposed disturbance of the site, may only be conducted under a permit issued by the Minister of Culture, Tourism and Recreation. The samples obtained and analyzed, and the work described below was conducted under permits issued to Storck in 1990 and Williamson (in ASI) in 1991.

Renewed field studies at the Sheguiandah site were first initiated in late November of 1990 when Julig, Storck, and T.W. Anderson (Geological Survey of Canada) visited the site to extract a pollen core from Swamp 3 (Storck *et al.* 1991) for AMS – ^{14}C dating and pollen studies. Field work was conducted again in May and June of 1991 for the purpose of investigating the limits of the site and re-opening several trenches excavated by Lee to re-examine the stratigraphy and vertical distribution of artifact material and obtain a fresh suite of sedimentary samples (Julig and Storck; Robertson *et al.* this volume). This latter field work was conducted in the context of an Archaeological Master Plan Study initiated by the Howland Township, Sheguiandah First Nation and the Ojibways of Sucker Creek, under the overall direction of Williamson of Archaeological Services Inc. (1992).

During the work in May and June of 1991, P. Barnett (Ontario Geological Survey, Sudbury), P. Karrow (Department of Earth Sciences, University of Waterloo), and P. von Bitter (Department of Invertebrate Paleontology, Royal Ontario Museum) joined the team, offered technical advice in the field and gathered on and off - site data (see Barnett; von Bitter, this volume) . Robert Lee was also invited and provided invaluable help in re-locating and identifying some of the original excavation units and further clarifying some of his father's interpretations. W.C. Mahaney (Geography, York University) also visited the site to make field observations on the sections and interpret the soils. These investigation are also explained in Robertson *et al.* (this volume), and in Julig and Storck (1992a).

Objectives of the Field Work

The primary objective of renewed investigations at Sheguiandah was to determine the age and cultural affiliation of the peoples who occupied the site, particularly those who deposited the artifacts in the so-called "till" deposits and who Lee interpreted as representing pre-Paleoindian groups dating 30,000 B.P. or greater (Lee 1957). These renewed investigations incorporate a new

Table 4.3. Sheguiandah Site Conjoined Artifacts (Lee Collections).

#	Refitted Specimens	Station	Depth (cm)	Stratigraphic Levels (Lee 1957)
1	973.1	7-1	17.5	II
	997.1	7-1	30.5	III
2	886	7-2	10.16-11.43	
	976	7-2	17.78	
3	98.2	7-3	0-7.5	I
	165.2	7-3	10	I
4	259	7-3	11.43	
	259	7-3	11.43	
5	78.1	7-4	0	I
	598.1a	7-4	66	V
6	87.1	7-4	0	I
	555.1	7-4	28	III
7	216.1	7-4	7.5	I
	244.1	7-4	5.1	I
8	244.1a	7-4	5-10	I
	324.1a	7-4	12.5-15	I
9	244.1b	7-4	5-10	I
	321.1	7-4	12.5-15	I
10	273.1	7-4	10-12.5	I
	526.1	7-4	38-48	IV
11	448.1	7-4	20.5-23	III
	530.1	7-4	45.5	IV
12	238.1	7-5	7.5	I
	515.1b	7-5	22.5	III
13	260	7-5	10.16	
	238	7-5	7.62	
	260	7-5	10.16	
14	346.1	7-5	15	II
	515.1a	7-5	22.5	III
15	480.1	7-5	10	I
	505.1	7-5	17.5	II
16	515	7-5	22.86	
	211	7-5	6.35	
17	1421.1	7-9	5.5-7.0	I
	1558.1	7-9	13.5	I
18	2014.1	7-11	0-6	I
	2027.1	7-11	0-6	I
19	2006	7-11	T	II
	2001	7-11	H	I
	2001	7-11	H	I
	2002	7-11	T	II
20	2114	7-12	T	II
	2101	7-12	T	II
21	2059	8-B	H	I
	2061	8-B	T	II
22	517	HD I	45.72-60.96	
	517	HD I	45.72-60.96	
23	1743	SA1 TT1	12.7-33.02	
	1449	MQ-R S of SA1	0-7.62	
24	1097	7-7	20.32	
	368	7-5	8.89	

T= transisitional
H=Humus

* not all specimens are included
(see Storck, this volume)

understanding of Great Lakes history and improved techniques in radiocarbon dating (AMS dating) and paleoenvironmental studies that Lee did not have at his disposal. One of the major objectives of the research program was to re-open selected trenches and test squares excavated by Lee to examine and sample the stratigraphy previously observed. This particular approach provided minimal intrusion into the site at this initial stage in the work, reduce the scope and cost of the field season, and allow us to evaluate Lee's interpretations by re-examining the same sedimentary profiles. It was anticipated that this approach would also determine the scale and orientation of possible future field work necessary to resolve the questions raised by Lee's work, our analysis of his sediment samples and our own field observations.

In addition to the overall objectives of the field work and the excavation approach mentioned above, the first season's field work had several specific objectives. These included the collection of new soil samples for analysis, complete soil descriptions, representative debitage samples and more complete pollen and macrobotanical data (Julig and Storck, this volume). Preliminary results of the analysis of the 1990 and 1991 samples are presented in Julig *et al.* (1994 a, b), and additional new results are presented below.

Pollen Coring and Radiocarbon Dating

Lee had reported that charcoal and other organic remains were present within and underlying the controversial diamicton deposits and it was planned to date these samples by AMS radiocarbon dating. Prior to this work the only radiocarbon date on Sheguiandah was a date of 9160 ± 250 BP from the base of the organic peat in Swamp 3 (Lee 1957). Upon examination of the Lee collections and the catalogues, it was evident that the small charcoal samples had been collected from the controversial Levels IV and V, and entered in the original catalogue, but for unknown reasons most of the samples with good context were missing (see R. Lee, this volume). One sample of charcoal in the collections was from the Hillside Dump (HD) section excavated by Lee, reported to be from a depth of approximately one metre, yielded an AMS date of 50 ± 70 BP (TO-2349). This (recent) date indicates considerable post-depositional mixing (possibly in historic times, due to logging or down-slope movement from the cattle pasturage?).

Lacking good organic samples for dating from the collections, five pollen cores were taken from Swamp 3 on November 23, 1990, with Thane Anderson (Storck *et al.* 1991). Lee (1957) had determined that the depth of sediments in Swamp 3 was approximately 2.7 m, with the base of the peat at approximately 1.7 m. Terasmae had previously done a pollen profile of this swamp (in Lee 1957, re-drawn in Anderson, this volume). The mineral sediments below the peat were very difficult to penetrate, and we were only able to core to a depth of 2.2 m with the Livingston corer. A summary of the sedimentary matrix and radiocarbon dates between 1.4 and 2.2 m depth are shown in Table 4.4, and grain size curves shows the sand strata (Figure 4.15).

The three radiocarbon dates (Table 4.4) at the interface between the peat and the mineral deposits (TO-2345, 2346, and 2347) are closely comparable to the date obtained by Lee (1957) from the base of the peat (9160 ± 250 years B.P.). These three dates, two on wood fragments, and one on peat, range from 9170 ± 80 to 9440 ± 80 BP and indicate that organic sedimentation started around 9500 years ago (see also dates in Anderson, this volume). The two more recent dates from the 210 cm and 220 cm depth on plant rootlets are probably from plants that grew in the swamp in middle Holocene times.

Later we excavated the Swamp (Julig and Storck 1992) and found artifacts at the interface of the peat and mineral sediments in Swamp 3 at the 180cm depth, and Swamp 4 at 63 cm depth. This indicates that occupation at this part of the site from ca. 9500 radiocarbon years BP, and continued at least until 7000 BP at Swamp 4. The water-worn artifacts suggest however an earlier occupation prior to ca. 9600 BP, when last been flooded (by the Early Mattawa flood event, or in a post-Algonquin Korah beach, Anderson and Lewis; Barnett, this volume).

Table 4.4. Radiocarbon dates and sediment context from Swamps 3 and 4, Sheguiandah Site.

Depth	Samples	Sediment Matrix	^{14}C (AMS)	Material
Swamp 3				
140		Peat		
150		Fibrous peat		
160		Fibrous peat	9230 ± 80 (TO-2345)	wood
170		Base of fibrous peat	9440 ± 80 (TO-2346)	peat
175		Fine sandy clay		
180	SA-10	Clay with fine sand		
190	SA- 20	Clay with pebbles	9170 ± 80 (TO-2347)	wood
200		Dense clay with pebbles		
210	SA-30	Clay with sand and pebbles	3710 ± 60 (TO-2348)	plant remains*
220	SA-40	Clay with sand and gravel	6200 ± 90 (TO-2350)	plant remains*
Swamp 4				
63		Sandy clay below peat	6870 ± 70 (TO-2743)	wood charcoal
63		Sandy clay below peat	7930 ± 80 (TO-2744)	peat

*Plant remains = small rootlets, possibly from plants that grew in the swamp in the mid-Holocene.

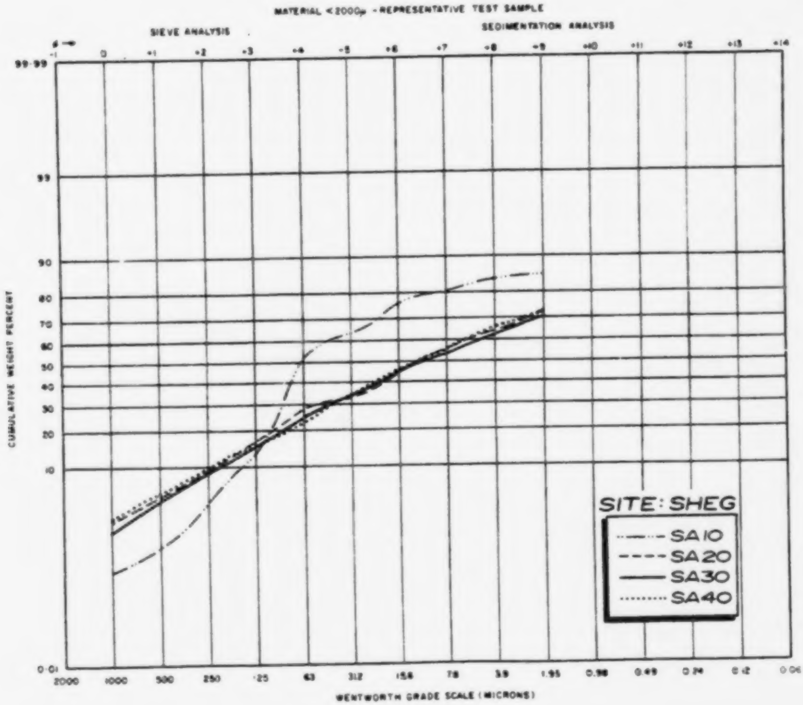


Figure 4.15. Cumulative grain-size curves for samples SA10, SA20, SA30, SA40 for mineral sediments below the basal peat, Swamp 3, Sheguiandah Site, Manitoulin Island. Samples analysed were taken with a Livingston corer in 1990. See Table 4 for sample depths and associated radiocarbon dates. Sample SA10, which is composed of nearly 40% fine sand, is likely lacustrine in origin, while samples SA20, SA30 and SA40 are till.

Geoarchaeology Field Methods and Activities

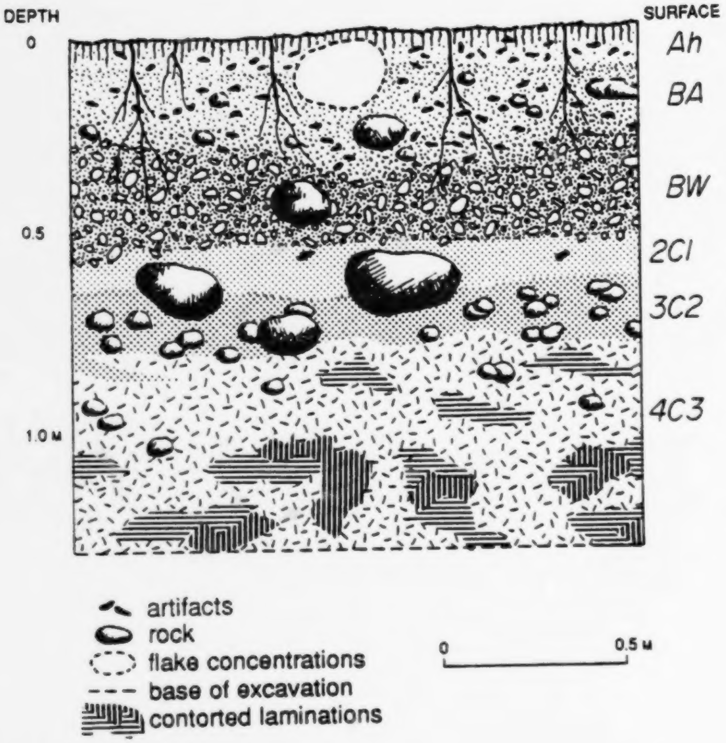
Because the primary objective of the excavations in 1991 was to duplicate Lee's field observations, other aspects of the stratigraphy of the site were to be re-examined, particularly the deposits in the Habitation Area and, to a lesser extent, the Mid-Quarry Ridge. To achieve both the primary research objectives and minimize the amount of field time required, portions of several of Lee's units were re-excavated to expose stratigraphic profiles at Stations 7-8, 7-9 and 8-B (Figures 4.16, 4.14, 4.18) in the Habitation Area and at an un-numbered trench on the margin of Swamp 1 on the Mid-Quarry Ridge. After each profile had been cleaned, a narrow strip of previously unexcavated sediments, 20 to 60 cm wide, was removed by trowel from the surface downward, following Lee's stratigraphic subdivisions. This was done to attempt to confirm the series of artifact "types" Lee reported for various stratigraphic units, to recover artifacts from the various strata that Lee had reported, particularly Levels III and V. We also recorded the fabric (dip and strike, by means of Brunton compass) using both natural pebbles as well as larger pieces of debitage as indicators. To achieve nearly total recovery of the debitage and smaller artifact fragments, the sediments were dry screened through one-quarter inch mesh hardware cloth and every fourth bucket of material was water screened through one-sixteenth inch mesh window screen.

Results

Cultural Stratigraphy

Lee (1957) reported at least five occupation levels in the upper 24 inches (60 cm) of deposits in the Habitation Area. These occupation or cultural levels include: Level I, which contained scattered Point Peninsula (Middle Woodland) artifacts at or near the surface; Level II, extending from the surface to a depth of 4-5 inches, which contained bifaces and other artifacts comparable to those at the George Lake I site (Greenman 1943; Greenman and Stanley 1943); Level III, extending between approximately 6 and 7 inches below the surface, which contained projectile points (particularly Late-Paleoindian forms, see also Storck, this volume); Level IV (stratigraphic Level III), occurring between 7 and 15 inches below the surface and representing the upper half of the so-called "till" unit, which contained large, thin bifaces (Figure 4.6); Level V (stratigraphic Level IV), occurring at a depth of between 15 and 24 inches and representing the lower half of the "till" unit, which contained small, thicker bifaces and finally, two unnumbered levels (?) below the "till", consisting of water-sorted sands and a lower-lying boulder pavement (Julig *et al.* 1994b: Figure 14.9), both of which apparently contained scattered flakes and other "battered objects" which Lee interpreted as having been made by humans (Lee 1957: Table 1, p.128).

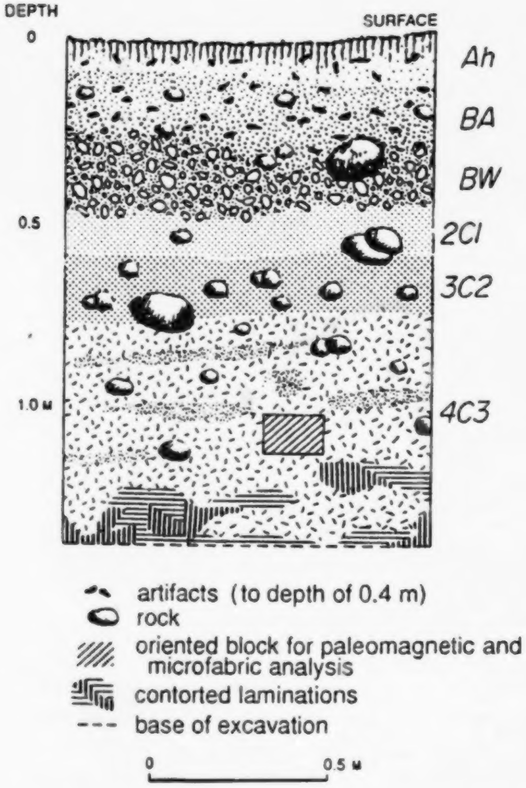
Our excavations along the west walls of two of Lee's test squares in the Habitation Area (Stations 7-8 and 7-9; Figures 4.16 and 4.17) produced a somewhat different artifact distribution than reported by Lee. Firstly, most of the artifacts (76%) occurred in the upper ten centimeters of the deposit and above the unit Lee interpreted at "till" (Level III). These artifacts include roughly shaped biface preforms (probably early stages in the reduction process), and fragments of thin, well made, leaf-shaped bifaces with sharp tips and broadly concave bases (possibly spear points).


DEPTH
0
0.5
1.0 M
SURFACE
Ah
BA
BW
2Cl
3C2
4C3
artifacts
rock
flake concentrations
base of excavation
contorted laminations
0
0.5 M

HORIZON DESIGNATIONS

Ah	sandy organic loam with many pebbles and artifacts
BA	sandy loam with pebbles and abundant artifacts
BW	coarse sandy loam with abundant granules; partly sorted
2Cl	coarse to medium lacustrine sand around boulders with a few archaeological flakes
3C2	indurated diamicton with abundant cobbles and boulders; no artifacts recovered
4C3	indurated diamicton with cobbles, patches of yellow-brown mottled clay, and contorted laminations of silt and clay

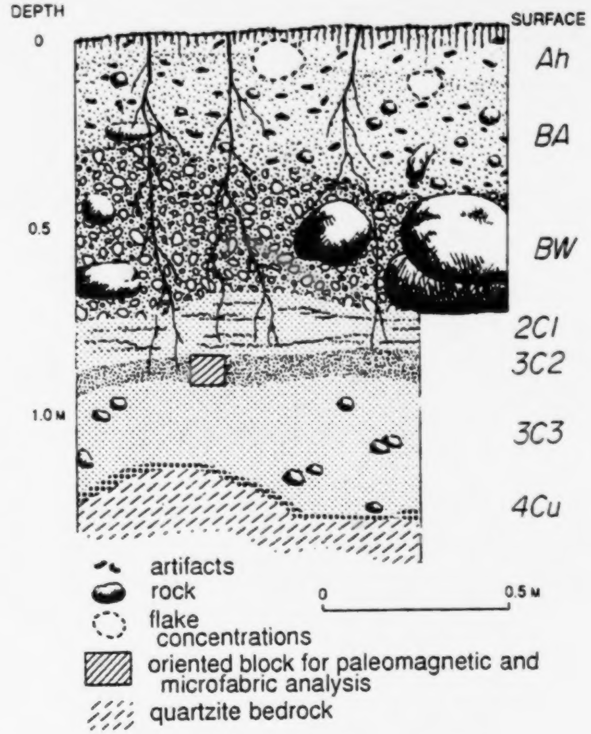
Figure 4.16. Stratigraphic profile of Station 7-8, West wall, Habitation Area, Sheguiandah Site, (BIHI-2; from Julig *et al.* 1994b).


DEPTH
SURFACE
0
0.5
1.0 M
Ah
BA
BW
2Cl
3C2
4C3
artifacts (to depth of 0.4 m)
rock
oriented block for paleomagnetic and microfabric analysis
contorted laminations
base of excavation
0
0.5 M

HORIZON DESIGNATIONS

Ah	sandy organic loam, abundant artifacts
BA	sandy loam with pebbles, abundant artifacts
BW	coarse sandy loam with gravel and stringers of granules
2C1	coarse to medium lacustrine sand, with boulders
3C2	diamicton with abundant cobbles and boulders
4C3	diamicton with cobbles, sandy stringers, patches of yellow brown mottled clay, and contorted laminations of silt and clay

Figure 4.17. Stratigraphic profile of 7-9, west wall, Habitation Area, Sheguiandah Site (BIHl-2; from Julig *et al.* 1994b).


DEPTH
0
0.5
1.0 M
SURFACE
Ah
BA
BW
2CI
3C2
3C3
4Cu
artifacts
rock
flake concentrations
oriented block for paleomagnetic and microfabric analysis
quartzite bedrock
0
0.5 M

HORIZON DESIGNATIONS

Ah	sandy organic loam; abundant artifacts
BA	sandy loam with pebbles and cobbles; abundant artifacts
BW	sandy gravelly loam with rounded cobbles and boulders
2CI	stratified silty sand
3C2	sand and silt (possible flow till/debris flow?)
3C3	silty sand with pebbles and mottled stratified clayey layers
4Cu	smear of grey clay directly on top of bedrock

Figure 4.18. Stratigraphic profile of Station 8-B, West wall, Habitation Area, Sheguiandah Site (BlHl-2; from Julig *et al.* 1994b).

Other tools from the upper ten centimeters of the deposit include: a fragments of a broad, thin biface, a variety of unifacially worked cutting/scraping tools, and a number of worked/utilized flakes that had been used as expedient tools. Unfortunately, no Plano points were recovered, although one or two of the thin, leaf-shaped bifaces exhibited parallel flaking and the type of control in knapping that is characteristic of Plano workmanship (Julig and Storck 1992; Julig *et al.* 1994b).

Very few artifacts were found in the lower part of the deposits at depths comparable to stratigraphic Levels III to V in Lee's work. Two fragments of well-made, leaf-shaped bifaces occurred at depths (19 and 23 cm respectively) equivalent to the lower part of Lee's stratigraphic Level III (18 to 36 cm). In the deposits underlying the lower diamicton (stratigraphic Level IV, i.e. in the water-sorted coarse sands and boulder pavement) only a few unworked flakes were found and some of these may be of natural origin.

More extensive excavation would be required to confirm Lee's observations on the distribution of artifacts in the stratigraphic sequence. However, the degree of post-depositional disturbance and mixing which has taken place in the profile, and interpretations concerning the origin(s) and age of the various sediments – particularly the diamictons in stratigraphic Levels III and IV, suggest the few recoveries from the lower strata may be mixed in due to site formation processes, including water level fluctuations (initial occupations) and frost heave and tree throws (subsequent occupations).

Geological Observations of the Diamicton, Levels III and IV

All of the geological consultants on the project commented that the interpretation of the stratigraphic Levels III and IV is made more complex by the fact that they occur within the weathering zone, the B soil horizon, and have been modified by soil formation processes. The depth of sediments overlying bedrock in the Habitation Area is highly variable, ranging from 0 to over 2.0 meters. The profile of a 2.1 m test pit to bedrock at Station 7-8 has been previously published (Lee 1957: Figure 1A; see also R. Lee, this volume: Figure 2.10). Three profiles in the Habitation Area (Figures 4.16 through 4.18, Stations 7-8, 7-9, and 8-B respectively), show that upper 50-75cm of the profiles are generally mixed, as reported by Lee, with his stratigraphic Levels III and IV corresponding generally to the Ba and Bw soil horizons in our profiles.

The geological consultants consider there may be at least three, and possibly four, separate depositional events represented in the Habitation Area profiles. Only Station 8-B was excavated to bedrock. Underlying the two mixed deposits (Lee's stratigraphic Levels III and IV), are variable stratified deposits of sand and granules intermixed in some area with a boulder pavement. Below this the deposits are variable, ranging from stratified to mixed, including a possible flow till (3C2, 4C3, Figures 4.16, 4.17; see also Barnett, this volume). No artifacts were recovered from the strata underlying the boulder pavement; however the area sampled was not large. Directly overlying the bedrock in Station 8-B is a thin "smear" (approx. 1.0cm) of clay (Figure 4.18), probably representing a lacustrine event immediately following deglaciation.

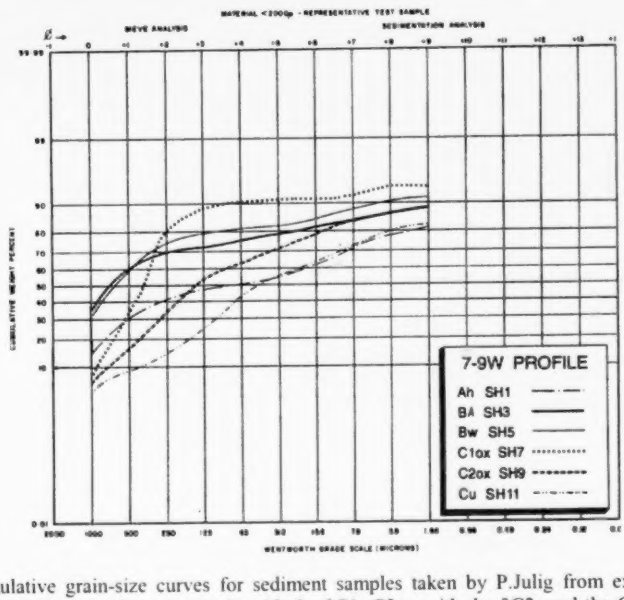


Figure 4.19. Cumulative grain-size curves for sediment samples taken by P.Julig from excavation unit 7-9W, Habitation Area. The C1ox sample corresponds with the 2C1; C2ox with the 3C2; and the Cu with 4C3 horizons shown in Figure 4.16 (see also Table 4.5).

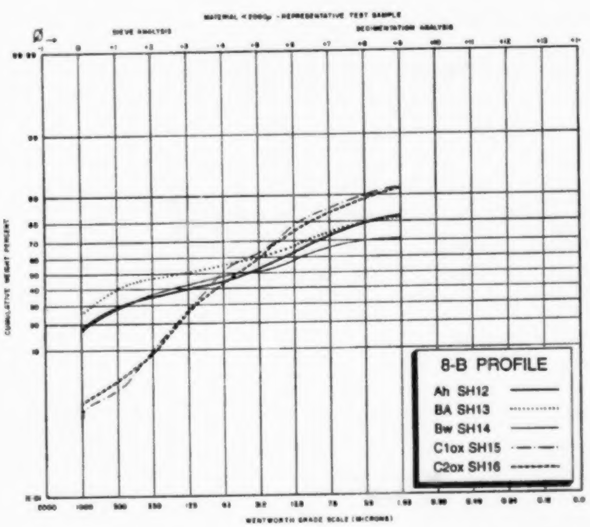


Figure 4.20. Cumulative grain-size curves for sediment samples taken by P. Julig from excavation unit 8-B, Habitation Area. The C1ox sample corresponds with the 2C1; and C2ox with the 3C2 and 3C3 horizons shown in Figure 4.18 (see also Table 4.5).

Table 4.5. Particle Size Data and Phosphorous, Sheguiandah Site, Excavated Sections.

Site Location	Sand (2mm- 63µm) (%)	Silt (63- 2µm) (%)	Clay (< 2µm) (%)	Organic Phosphorous (PPM)
Habitation Area, Station 7-9W				
Ah	50.5	31.5	18.0	1.69
BA	76.0	12.0	12.0	0.48
BW	81.5	11.0	7.5	0.13
C1ox	90.2	2.8	7.0	0.18
C2ox	63.0	25.0	12.0	0.13
Cu	43.0	39.5	17.5	No Data
Habitation Area, Station 8-B				
Ah	40.0	42.0	18.0	0.63
BA	56.0	25.5	18.5	0.19
BW	44.0	26.5	29.5	0.13
C1ox	51.0	41.0	8.0	0.13
C2ox	42.5	49.0	8.5	0.47
Mid-Quarry Ridge				
Ah	33.0	49.0	18.0	1.05
BW	40.5	43.0	16.5	0.23
C1ox	24.0	54.0	22.0	0.13
C2ox	11.5	42.5	46.0	0.47
Cu	46.0	44.0	10.0	No Data

Additional test pits to bedrock are needed to provide a clearer picture of the surficial geological history of the site. However, several observations on the controversial diamictons in stratigraphic Levels III an IV are worthy of note. First, these "strata" contain no evidence of a strong fabric, which is contrary to what would be expected if they were primary glacial deposits (see also R. Lee, this volume). Rather, oblong pebbles in the matrix appear to be oriented randomly. While this could be the result of pedogenic processes, since the deposits are in the weathered horizon, there is also little evidence for consistent striations on boulders in the boulder pavement underlying stratigraphic Level IV at the 0.6 meter level in the Habitation Area (Figures 4.16 and 4.17; see also Barnett, this volume). Striations would be expected if the overlying stratum were till in primary deposition. It should be noted that there is no evidence of a lodgment till emplaced directly over bedrock at the base of Station 8-B (Figure 4.18). At that locations there appears to be lacustrine sediments directly over bedrock.

The particle size data and clay mineralogy are shown on Tables 4.5 and 4.6, for Stations 7-9 and 8-B, and the Mid Quarry Ridge (MQR), and the cumulative grain-size curves in Figures 4.19 and 4.20. Both Station 7-9 and 8-B data indicate both mixed (upper mixed deposits with artifacts and lower flow till, this being the only till) and sorted samples, with 7-9 having a sandy stratum (C1ox) overlying the lower mixed deposits (C2ox, Cu). The sand, silt and clay percentages of the Cu sample are shown in Table 4.5, corresponding to the 4C3 stratum.

This section was also analyzed by Peter Barnett (this volume) and his analysis of the same stratum (Figure 6.9) is interpreted by Barnett as the only on-site glacial till at Sheguiandah.

Table 4.6. Clay mineralogy, Sheguiandah Site, Sections excavated in 1991.

Soil Horizon	Depth (cm)	K	H	I	I-S	V	Chl	Q	P	O
Habitation Area, 7-9W-1										
Ah	0-20	tr	tr	tr	tr	X	-	XX	tr	tr
B1	20-30	X	X	tr	tr	X	X	XX	tr	tr
Bw	30-46	X	tr	tr	tr	X	tr	X	-	tr
C1ox	46-65	tr	-	X	tr	Tr	tr	XX	-	X
C2ox	65-88	X	X	XX	X	X	X	XXX	X	XXX
Cu	88-90	X	-	X	tr	X	tr	XXX	X	X
Cu	100-110	X	tr	XXX	X	X	X	XXX	X	XX
Cu	110-130	X	tr	XXX	X	X	tr	XXX	X	XX
Habitation Area, 8-B-1										
Ah	0-15	tr	tr	-	tr	X	X	XX	-	tr
BA	15-35	tr	tr	tr	tr	-	tr	XX	-	tr
BW	35-62	-	-	tr	tr	Tr	tr	X	-	tr
C1ox	62-93	XX	-	XXX	X	Tr	XX	XXX	X	X
Cu	93+	X	-	X	tr	X	X	XXX	tr	tr
(MQR)										
Ah	0-10	XXX	X	tr	X	XX	tr	X	X	tr
Bw	10-38	XXX	-	X	XX	XX	XX	X	X	XX
Cox1	38-58	XX	-	-	tr	-	XX	XX	-	tr
Cox2	58-80	XXX	-	XX	XX	Tr	tr	XXX	X	XXX
Cu	80+	tr	-	XX	XX	XX	X	XX	XX	XX
Swamp 3										
SH19	135-145	X	tr	XX	X	X	X	XXX	X	X
SH20	180-190	X	-	XX	X	X	X	XXX	XX	X
SH21	200-210	X	-	XXX	XX	X	XX	XXX	XX	XX
SA10	180	X	tr	XXX	X	-	XX	XXX	X	XXX
SA20	190	X	tr	XX	X	X	XX	X	X	XXX
SA30	210	XX	tr	XXX	X	Tr	X	X	X	XXX
SA40	220	-	-	X	-	-	X	X	X	XX

* *In samples Sa20 and Sa30 a small amount of smectite was found*

Mineral abundance is based on peak height: nil (-); minor (tr); small (X); moderate (XX); and abundant (XXX). Clay minerals are kaolinite (K), metahalloysite (H), illite (I), illite-smectite (I-S), vermiculite (V), chlorite (Chl). Primary minerals are quartz (Q), plagioclase feldspar (P), and orthoclase (O).

The clay mineralogy analysis was conducted for the sections (Table 4.6), to determine if clay mineral spectra may indicate amounts of (expandible) clays (e.g. smectite, illite-smectite) that may be related to Glacial Lake Agassiz inflow. This may occur from the Early Mattawa flood event, as this pattern was evident at Cummins site in the Superior basin(Julig *et al.* 1990). The data is presented here so that other scholars may use it in the future.

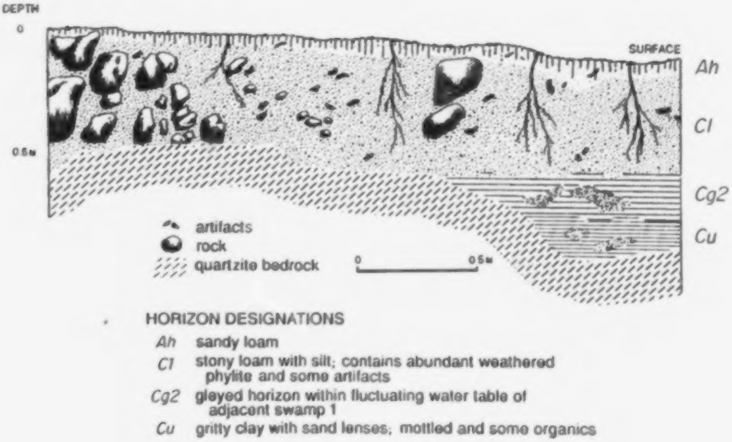

DEPTH
0
0.5m
SURFACE
Ah
Cl
Cg2
Cu
artifacts
rock
quartzite bedrock
0
0.5m
HORIZON DESIGNATIONS
Ah sandy loam
Cl stony loam with silt; contains abundant weathered phylite and some artifacts
Cg2 gleyed horizon within fluctuating water table of adjacent swamp 1
Cu gritty clay with sand lenses; mottled and some organics

Figure 4.21. Stratigraphic profile of Mid-Quarry Ridge trench (MQR), West wall, Sheguiandah Site (from Julig *et al.* 1994).

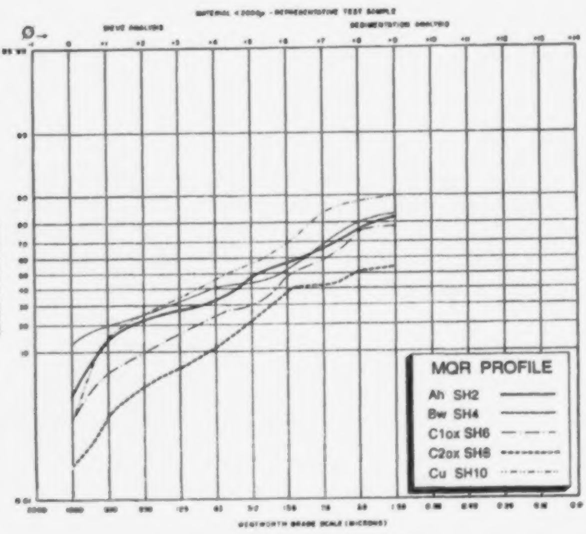


Figure 4.22. Cumulative grain-size curve of the Mid Quarry Ridge (MQR), 1991 samples, Sheguiandah Site (BIHI-2).

Geological Observations at the Mid-Quarry Ridge and Swamp 3 Locations

Other locations re-examined as part of our recent field investigations included the Mid-Quarry Ridge (MQR) trench and Swamps 3 and 4 (Figure 4.1). A stratigraphic profile of the re-exposed west face of the MQR trench, initially excavated by Lee, is illustrated in Figure 4.21. Field observations confirmed that the C horizon is a mixed deposit containing some artifacts, as reported by Lee; however, the mixing shown in the granulometry (Figure 4.22) may be due to pedogenic processes. No artifacts were recovered from the underlying gleyed Cg and Cu horizons (Figure 4.21).

Geological Observations at Swamps 3 and 4

As mentioned previously, five cores were taken from Swamp 3 on November 23, 1990, with T. Anderson of the Geological Survey of Canada. Lee (1957) determined through excavation that the maximum depth of sediments overlying bedrock in Swamp 3 is approximately 2.7 meters, with the base of the peat at approximately 1.7 meters. As mentioned, during our work it was not possible to penetrate the mineral sediments to bedrock with the Livingston corer. A summary of the sedimentary matrix between 1.4 and 2.2 meters is shown in Table 4.4, along with five AMS radiocarbon dates. This needed to be checked more carefully, and in August 1991, trenches were excavated in Swamps 3 and 4 in order to: 1) examine the stratigraphy to bedrock, 2) obtain a full suite of sediment samples for pollen analysis, and 3) to confirm the context of quartzite artifacts relative to the previously reported radiocarbon dates (see Anderson, this volume).

The stratigraphic profile of a 2.2 metre test trench in Swamp 3 is illustrated in Figure 4.23. Artifacts were recovered at the base of the peat, in a sandy clay 10-15 cm horizon. The associated radiocarbon dates range from 9170 ± 80 to 9440 ± 80 BP (Table 4.4). Below 1.5 meters, the sediments were massive clay with gravel and boulders. No artifacts were present at this level (Julig and Storck, 1992; Julig *et al.* 1994b). Cumulative grain-size frequencies (Figure 4.15) indicate a sandy stratum at 145 to 155 cm, with sample SA-10 being over 40% fine sand, with this silty sand being washed in by water (see Anderson, this volume).

There is also a slight difference between the depth of the base of the peat as determined in the 1990 corings (170cm) and that shown in the profile in Figure 4.23. This discrepancy is mainly due to variations in the upper surface of the peat and settling of the peat as Swamp 3 dried out in the August summer heat (see also, Anderson, this volume).

Swamp 4 is a small peat-filled depression located between Swamp 3 and the top ridge (Figure 4.1). The depth of sediments overlying bedrock is less than one metre (Figure 4.24). A single one by two metre test pit was excavated to determine the cultural and natural stratigraphy of Swamp 4. Underlying approximately 0.5 metres of dark peat was a transitional silty-clay-peat horizon with artifacts. Numerous quartzite unifaces (utilized flakes) were recovered from an underlying sandy-silty-clay unit of variable thickness, but artifacts were absent in the coarse gravel overlying bedrock (Figure 4.24). Organic samples were recovered in close association with the artifacts, and range from 6870 ± 70 (charcoal), to 7930 ± 80 on peat (Table 4.4). This indicates an occupation approximately 1500 to 2500 years after the artifacts were deposited in the adjacent Swamp 3. In none of these excavations did we recover artifacts in glacial till, but in the overlying lacustrine and water-washed deposits.

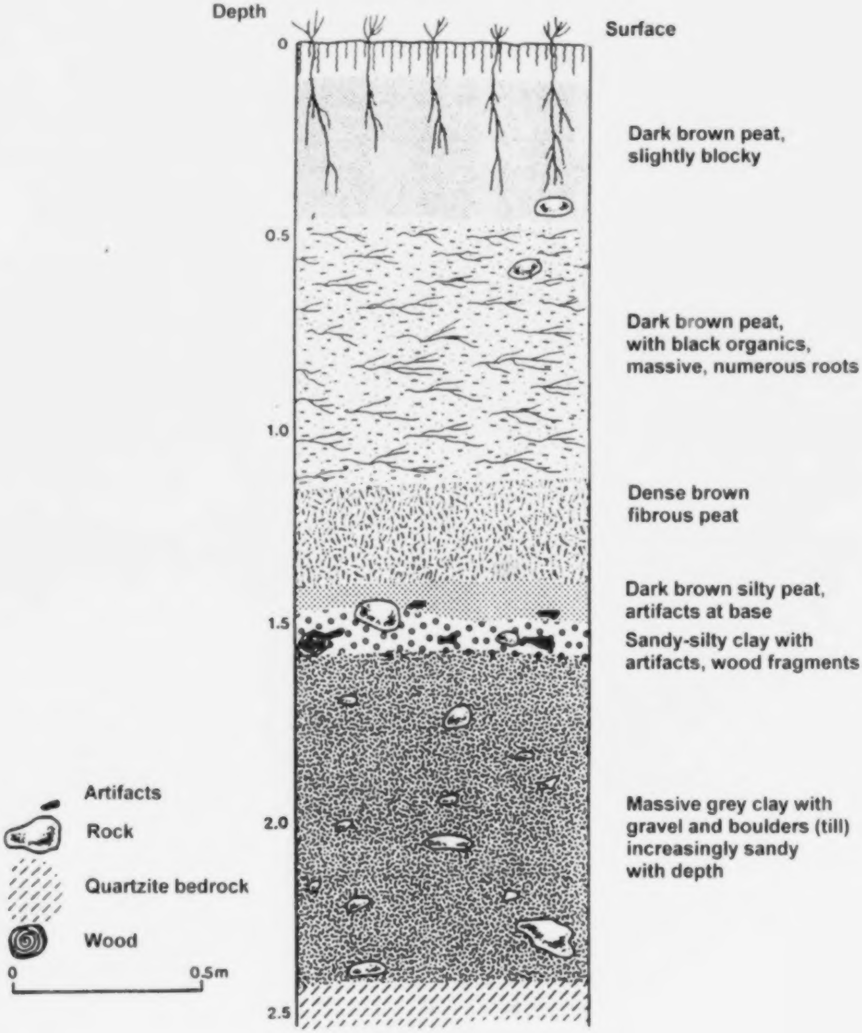

Depth
Surface
0
0.5
1.0
1.5
2.0
2.5
Dark brown peat, slightly blocky
Dark brown peat, with black organics, massive, numerous roots
Dense brown fibrous peat
Dark brown silty peat, artifacts at base
Sandy-silty clay with artifacts, wood fragments
Massive grey clay with gravel and boulders (till) increasingly sandy with depth
Artifacts
Rock
Quartzite bedrock
Wood
0
0.5m

Figure 4.23. Stratigraphic profile of Swamp 3, Sheguiandah Site (BlHl-2).

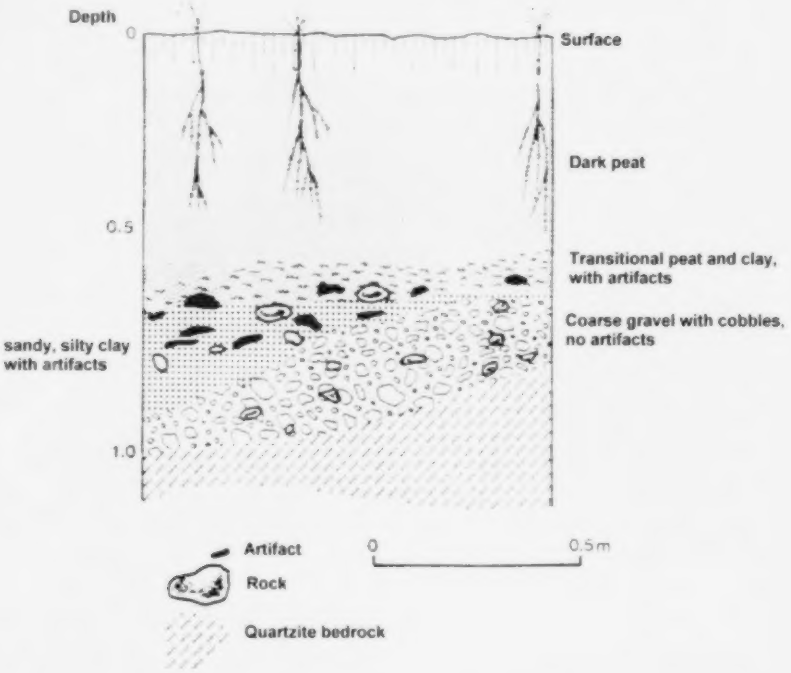

Depth
0
0.5
1.0
Surface
Dark peat
Transitional peat and clay, with artifacts
Coarse gravel with cobbles, no artifacts
sandy, silty clay with artifacts
Artifact
Rock
Quartzite bedrock
0
0.5m

Figure 4.24. Stratigraphic profile of Swamp 4, Sheguiandah Site (BlHl-2).

Summary

Analysis of existing collections and those from the 1990-1991 investigation from the Sheguiandah site indicate that Thomas Lee's field observations were generally quite accurate. In our own work we observed, and can independently confirm, most aspects of the stratigraphy he described. The controversial deposits in the Habitation Area (the "tills" in stratigraphic Levels III and IV) are, as Lee described, mixed deposits (diamictons). This is indicated by the majority of the sediment samples from Levels III and IV which have general linear grain size curves. However, other lines of evidence (quartz sand-grain morphology, fabric analysis, the matching of conjoined artifacts from different strata) indicate the Levels III and IV are not tills. In the next chapter Barnett does a comparison to off-site tills two compare the deposits to known tills, and near-shore beach deposits of lake Algonquin Korah phase. From our on-site geoarchaeological studies the questionable "till" deposits are probably not of glacial origin (i.e. tills) but, instead, are likely the product of other non-glacial geomorphic processes (including lacustrine), considerably modified by pedogenesis.

During his cataloguing and analysis of the artifacts, Lee refitted broken biface fragments obtained from various strata in the Habitation Area. An analysis of these conjoined pieces by the senior author with respect to their excavated context indicated that considerable post-depositional mixing has occurred throughout the stratigraphic profile (Table 4.3). For example, specimens recovered from near surface contexts (e.g. Levels I and II) conjoined with specimens from Level III, to Level V diamictons.

These data on the refitted specimens indicate that post-depositional mixing, probably originating from tree falls, downslope movement, frost action and other geomorphic activities may have been a significant factor in site formation in the Habitation Area, leading to the "till-like" deposits.

Field observations did not confirm cultural stratigraphy described by Lee. We found few artifacts from depths corresponding to Lee's cultural Levels III to V. The analysis of Lee's artifact collection indicates that there are few specimens from Levels IV and V and some of the flakes, we believe, may be of natural origin. This pattern of decreasing artifact recovery with depth, combined with evidence of mixing between strata, calls into question Lee's observations on the distribution of artifacts in the sediments and his interpretations concerning the cultural stratigraphy (Julig *et al.* 1994b).

The recoring and re-dating of organic material from Swamp 3 provides support for Lee's single date of 9160 ± 250 BP for the onset of organic sedimentation at the site. The sandy deposits (40% fine sand) contain the artifacts dating to ca. 9500 BP, and immediately below this the deposits are mixed deposits, or till. However we will not record any artifacts in this glacial till.

Lee observed (1957) artifacts from the Habitation Area that were water worn, and some of these were selected for further study. Among the water worn artifacts, is a broken biface with worn flake-scar ridges and a worn fractured surface (Figure 4.8, A) indicating that the artifact was water-worn subsequent to its being broken during manufacture or use. Numerous quartzite flakes also appear to have been water worn to various degrees. Lee (1957) implied that this abrasion was the result of glacial action. We suggest, however, that this weathering is the result of water action and that the artifacts could have been water worn during the Korah phase or high lake levels associated with the post-Lake Algonquin /Mattawa phase lake commencing ca. 9600 BP (Lewis and Anderson 1989; Julig 1990; Anderson and Lewis, this volume).

Geoarchaeological studies are clearly necessary to establish the detailed context of excavated assemblages within the sedimentary matrix. This is especially true for sites which have been subject to complex geomorphic processes during the period of human occupation. Clearly, much of the controversy surrounding the interpretation of Sheguiandah centered on the geomorphology of the deposits. Some of this controversy derives from the complexities of interpreting geoarchaeological deposits, while another part – a significant part in the case of Sheguiandah – derives from the difficulties of organizing and coordinating the work of many specialists required. Both the need for such multidisciplinary work and the ability to bring that work to a successful conclusion are required before geoarchaeological studies will reach their full potential.

Analysis of both the sediment and artifact collections and their context, along with ^{14}C dates from the Swamps 3 and 4 indicate long-term use of this site, from ca 9500 B.P. to the Archaic, and finally to Middle Woodland times, on the lower terraces. Water-worn artifacts suggest initial occupation prior to the last high water stand possibly at 9600 B.P. However, are relatively few water-polished specimens, and no fluted points, or other cultural evidence of an occupation prior to the Late-Paleoindian /Plano period.

Acknowledgements

We wish to acknowledge the support of many individuals and institutions in this research. Most of the field investigations were conducted in the context of an Archaeological Master Plan Study of Howland Township and adjacent reserves of Sheguiandah First Nation and the Ojibways of Sucker Creek, under the direction of Dr. Ron Williamson of Archaeological Services Inc. We acknowledge the invaluable assistance of Chief Max Assinewai (Sheguiandah First Nation), Chief Pat Madahbee (Ojibways of Sucker Creek), and Mr. Frank Reynolds (Economic Development Officer for the Township of Howland). Funding for this master plan was provided by the Ontario Ministry of Culture and Communications, the Ontario Ministry of Northern Development and Mines, and the Community futures program. Analysis of collections and sediments obtained by Thomas Lee nearly 40 years ago was funded by research grants 410-89-1055 and 410-90-1160 to P. Julig from the Social Sciences and Humanities Research Council of Canada. Radiocarbon dates and sediment analysis were funded by a grant from The Ontario Heritage Foundation to P. Julig, W. Mahaney, and R. Beukens. Peter Storck was most influential in organizing the multi-disciplinary aspects and experts, and was co-author on an earlier report on these investigations. Robert Lee provided valuable information on the work of his father, Thomas Lee. Geological consultants included Peter Barnett, Paul Karrow, and Peter von Bitter, and their help is gratefully acknowledged. Thane Anderson provided assistance in the re-coring of Swamp 3. Mr. Andrew Stewart, Research Associate at the Royal Ontario Museum, assisted in many aspects of the field investigation. The Royal Ontario Museum provided travel support to visiting consultants. Emile Hustiu, Department of New World Archaeology (ROM), and Janet Allin, cartographer for Department of Geography, Atkinson College, York University prepared the final artwork for the figures. We wish to thank the field crew and volunteers for their excellent work: Martin Cooper, Alicia Hawkins, Dana Kelly, Dawn Kruger-Stoliker, Adam Lord, Eva MacDonald, Robert MacDonald, Kathy Mills, David Robertson, and Deborah Steiss. Finally, the artifact illustrations were done by Vera Moffat.

References

Archaeological Services Inc. 1992. Report on Phases 1 and 2 of the Archaeological Master Plan for the Township of Howland, Ojibways of Sucker Creek and the Sheguiandah First Nation. Manuscript on file for the Ontario Ministry of Citizenship, Culture and Recreation, Toronto.

Dreimanis, A. 1989. Tills: Their Genetic Terminology and Classification. In *Genetic Classification of Glacigenic Deposits*, edited by R.P. Goldthwait and C.L. Matsch. Final Report of the Commission on Genesis and Lithology of Glacial quaternary Deposits of INQUA. A.A. Balkama/Rotterdam/Brookfield.

Flint, R.F. 1971. *Glacial and Quaternary Geology*. New York: John Wiley and Sons, Inc.

Greenman, E.F. 1943. An Early Industry on a Raised Beach near Killarney, Ontario. *American Antiquity* 8(3): 260-265.

Greenman, E.F. and G.M. Stanley. 1943. The Archaeology and Geology of Two Early Sites near Killarney, Ontario. *Papers of the Michigan Academy of Science, Arts and Letters* 28: 505-531.

Julig, P.J. 1990. The effect of Lake Agassiz Flood Events on Northern Great Lakes Paleo-indian Sites: Examples from the Superior and Huron Basins. Paper presented at the joint meetings of the Canadian Quaternary Association and the American Quaternary Association, University of Waterloo, June 1991.

Julig, P.J. 1994. *The Cummins Site Complex and Paleoindian Occupations in the Northwestern Lake Superior Region*. Toronto: Ontario Heritage Foundation, Ontario Archaeological Reports 2.

Julig, P.J., J.H. McAndrews and W.C. Mahaney. 1990. Geoarchaeology of the Cummins Site on the beach of proglacial Lake Minong, Lake Superior basin, Canada. In *Archaeological Geology of North America*, edited by N.P. Lasca and J. Donahue, pp. 21-50. Boulder, Colorado: Geological Society of America, Centennial Special Paper 4.

Julig, P.J, W.C. Mahaney, and P.L. Storck. 1991. Preliminary Geoarchaeological Studies of the Sheguiandah Site, Manitoulin Island, Canada. *Current Research in the Pleistocene* 8: 110-114.

Julig, P.J. and P.L. Storck.1992. Survey and Re-excavation of the Sheguiandah Site. *In* Archaeological Services Inc.: Report on Phases 1 and 2 of the Archaeological Master Plan for the Township of Howland, Ojibways of Sucker Creek and the Sheguiandah First Nation, pp.30-89. Manuscript on file with the Ontario Ministry of Citizenship, Culture and Recreation, Toronto.

Julig, P.J., R.P. Buekens, and W.C. Mahaney. 1994a. Geochronology of the Sheguiandah Site (BlHl-2), Manitoulin Island, Ontario. Report to the Ontario Heritage Foundation.

Julig, P.J., P.L. Storck and W.C. Mahaney. 1994b. Re-investigations at Sheguiandah: the application of a Geoarchaeological Approach. In *Great Lakes Archaeology and Paleoecology: Exploring Interdisciplinary Initiatives for the Nineties (symposium proceedings)*, edited by R.I. MacDonald, pp. 237-262. University of Waterloo: Quaternary Sciences Institute.

Julig, P.J. n.d. SEM use-wear studies of Sheguiandah site quartzite artifacts from Swamp 4. Manuscript on file, Archaeology Laboratory, Laurentian University.

Krinsley, D.H. and J.C. Doornkamp. 1973. *Atlas of Quartz Sand Surface Textures*. Cambridge University Press, Cambridge.

Lee. T.E. 1953. A Prelimianry Report on the Sheguiandah Site, Manitoulin Island. *National Museum of Canada Bulletin* 128: 58-67.

Lee. T.E. 1954. The First Sheguiandah Expedition, Manitoulin Island, Ontario. *American Antiquity* 20(2): 101-111.

Lee. T.E. 1955. The Second Sheguiandah Expedition, Manitoulin Island, Ontario. *American Antiquity* 22(1): 79.

Lee. T.E. 1957. The Antiquity of the Sheguiandah Site. *Canadian Field Naturalist* 71(3): 117-137.

Lewis, C.F.M, and T.W. Anderson. 1989. Oscillations of levels and cool phases of the Laurentian Great Lakes caused by inflows from glacial Lakes Agassiz and Barlow- Ojibway. *Journal of Paleolimnology*, 2: 99-146.

Mahaney, W.C, W.B. Vortisch, and P.J. Julig. 1988. Relative differences between glacially crushed quartz transported by mountain and continental ice: Some examples from North America and East Africa. *American Journal of Science* 188: 810-826.

Sanford, J.T. 1957. Geologic observations at the Sheguiandah site. *The Canadian Field Naturalist* 71: 138-148.

Sanford, J.T. 1971. Sheguiandah Reviewed. *Anthropological Journal of Canada* 9(1): 2-15.

Stein, J.K. and W.R. Farrand. 1985. Context and Geoarchaeology: An Introduction. In *Archaeological Sediment in Context*, edited by J.K. Stein and W.R. Farrand, pp.1-3. Orono: University of Maine, Centre for the Study of Early Man, Institute for Quaternary Studies.

Storck, P.L., P.J. Julig, and T.W. Anderson. 1991. Pollen coring activities at the Sheguiandah site, Manitoulin Island. *Second Annual Archaeological Report, Ontario (New Series)* 2: 112-114.

Chapter 5

Projectile Points from the Sheguiandah Site

Peter L. Storck

Abstract

This paper is a compendium of projectile points from Sheguiandah, drawn from the site collection in the Canadian Museum of Civilization, a smaller collection at the Royal Ontario Museum and a private collection. Roughly fifty percent of the sample, comprising lanceolate and stemmed lanceolate points, is attributable to Late Paleoindian (Plano) people, the site's earliest occupants. These people may also have made the smaller sample of side-notched points that elsewhere in the upper Great Lakes region have been found associated with Eden/Scottsbluff material. A small number of stemmed, side- and corner-notched points indicates that Sheguiandah was also occasionally visited or briefly occupied by Archaic and perhaps Woodland peoples during the middle and later Holocene.

Résumé

Cet article recense les pointes de projectile trouvées à Sheguiandah. Elles proviennent de la collection du site du Musée canadien des civilisations, d'une collection plus petite située au Musée royal de l'Ontario et d'une collection privée. Environ cinquante pour cent de l'échantillon, composé de pointes lancéolées avec ou sans pédoncule, sont attribuables aux peuples de la période paléoindienne récente (Plano), les premiers occupants du site. Ces peuples ont peut-être aussi confectionné le plus petit échantillon de pointes à encoches latérales qui ont été associées, ailleurs dans la région supérieure des Grands Lacs, à des matériaux de la culture Eden-Scottsbluff. Un petit nombre de pointes à pédoncule, à encoches latérales et en coin indiquent que Sheguiandah a aussi été visité ou occupé brièvement par des peuples de l'archaïque archaïque et peut-être du sylvicole pendant le milieu et la fin de la période Holocène.

Introduction

This paper summarizes data on the projectile points Lee collected or excavated from Sheguiandah between 1952 and 1955. Lee illustrated and/or briefly described some of these artifacts in several papers published during or just after the field work (Lee, 1954, 1955, 1957). Unfortunately, he did not subsequently publish a comprehensive study of the entire sample. Today, the total number projectile points he recovered is somewhat uncertain, in part because of the lack of a comprehensive study by Lee, but also because not all of the material was housed at Lee's host institution, the National Museum of Canada in Ottawa (today the Canadian Museum of Civilization). A further difficulty in tracking all of the material results from the fact that it is represented by unevenly detailed catalogue and field records. Most of the projectile points, for example, were housed with the rest of the artifact material at the Canadian Museum of Civilization, but at least six specimens (as well as a small number of other artifacts) were

The Sheguiandah Site: archaeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario, edited by P. Julig. Canadian Museum of Civilization, Archaeological Survey of Canada, Mercury Series Paper 161, 2002.

donated to the Royal Ontario Museum (ROM) in Toronto. Lee also apparently donated material to other institutions and some individuals (see Robert Lee, this volume). Judging from the ROM catalogue numbers, all prefixed with the number 955, the donation to the ROM occurred in 1955, the final year of Lee's excavation at the site. Interestingly, the six points Lee donated are lanceolate or stemmed lanceolate Plano (Late Paleoindian) points, together comprising almost half of the total sample of 16-20 Plano points available for this study (the higher number includes specimens difficult to classify). This numerical bias suggests that the material donated to the ROM was selected to highlight the Paleoindian occupation(s) at Sheguiandah.

Description of the Material

The sample discussed in this paper includes specimens directly examined as well as those illustrated by Lee but not present in the collections from the Canadian Museum of Civilization or the ROM, and therefore not available for direct examination. Although as a whole Lee's drawings are excellently detailed and thus easily identified with particular specimens, three of the earlier drawings published in 1954 are not (see Lee 1954: Figure 35, #1, 2, 5) and, lacking precise identifications in the figure caption, are different enough from any of the studied specimens to possibly represent additional artifacts (see Table 5.1: 1954-35-1, 1954-35-2 and 1954-35-5). Because of this uncertainty, the sample discussed in this paper contains between 38 and 41 specimens.

Of the maximum number of 41 projectile points reported here, six are tip fragments, three or four are mid-sections and one is a complete blade with a portion of the haft element. The remaining 30 specimens are either basal fragments or complete artifacts, and are thus classifiable by basal treatment. Of these 30, 14 or 15 are unstemmed lanceolate, three are stemmed lanceolate, two are stemmed with triangular blades, seven are side-notched and two or three are corner-notched. The following description presents the material by cultural affiliation or shared morphological attributes.

Late Paleoindian (Plano)

A total of 20 projectile points are classified as being of Late Paleoindian (Plano) cultural affiliation (including four tentatively classified specimens; note that two additional specimens; 1954-35-1 and 1954-35-2, may not represent separate artifacts and, thus, are not included in the total). This sample may be larger since seven specimens of broadly similar morphology could not be classified. One artifact was made from chert (O Ma 1-2109) while the other 19 were made from quartzite, presumably obtained from the bedrock underlying the site. Five are tip or mid-section fragments, one is a blade with a portion of the haft element, eleven are unstemmed lanceolates and three are stemmed with lanceolate blades.

Two of the Late Paleoindian unstemmed lanceolate points from Sheguiandah deserve special mention. The first specimen is illustrated in Lee (1957, Figure 4, number 12; see Figure 5.2, number 3 in this paper). In his 1957 paper, Lee remarked that visiting scholars who examined some of the recently excavated material from Sheguiandah compared the specimen in question to both *Plainview* and fluted projectile points, although Lee felt that the location of maximum blade width on the Sheguiandah specimen was "...broadest above the midline..." and therefore closer to *Folsom*. However, Lee went on to say that the fluting on this specimen was "...indefinite...".

In my opinion, this specimen was not fluted, but basally thinned by the removal of several contiguous flakes roughly 8.0 mm long along the margin of the base on one face and a series of contiguous flakes roughly 4.0 to 4.5 mm long on the opposite margin. This basal treatment, combined with the excellent parallel, collateral flaking, perpendicular to the long axis of the specimen, suggests that the specimen is a Late Paleoindian point.

The second specimen deserving special mention (O Ma 1-2109; Table 5.1; Figure 5.6, number 6) was drawn by Lee but not published. It has clearly been substantially thinned on one face, presumably from the base. Unfortunately, the specimen could not be located for this study and is represented only by Lee's drawing. [The artifact, part of a group of three-- see Figure 5.6, #5, 6, and Figure 5.7, #4, in this paper-- was donated by Lee to a colleague, vocational archaeologist Frank Ridley, for safe keeping; all three may eventually be rediscovered in Ridley's collection.] Since the specimen could not be directly examined, it is not possible to see how (or if) the base was prepared for thinning, or whether the opposite face was also thinned. Because of this uncertainty, and the fact that the margins and base of the artifact do not appear to have been ground (an attribute Lee clearly indicated on his drawings if present), the specimen is tentatively classified as Plano.

Generally speaking, the points classified in this paper as Late Paleoindian in cultural affiliation were so identified because they exhibit, individually, one or more of the following attributes: lanceolate shape, diamond-shaped cross-section in the upper part of the blade or at the tip and a facial flaking pattern characterized by parallel or oblique collateral flake scars. In addition, two specimens exhibit squared stems comparable to those seen on *Eden*, *Scottsbluff* and *Alberta* points (see, for example, Agenbroad 1978; Frison and Todd 1987). As a group, the sample from Sheguiandah exhibits the following tendencies in these attributes:

- *blade cross-section*: some specimens show a gradual change from bi-convex at mid-section to diamond-shaped near the tip.

- *facial flaking*: flake scars tend to be parallel and are oriented perpendicularly, or more rarely, obliquely to the long axis of the specimen; scars tend to be roughly uniform in size and shape (being generally rectangular) and merge smoothly along the midline by overriding or slightly undercutting scars originating from the opposite edge (i.e. collateral flaking); the quality of the flaking tends to vary between different faces, one face exhibiting a more regular pattern of flaking than the opposite face. In two instances of uneven bifacial flaking (O Ma 1-259, Figure 5.6, number 1, and O Ma 1-290, not illustrated) the curvature of the original flake blank from which the point was made is apparent in the finished artifact.

- *stem*: tends to be off-set from the blade by only a millimetre or two; on one specimen (ROM 955.161.241, Figure 5.2, number 5) this appears to have been achieved by full facial flaking (both transverse and collateral), followed by minor edge retouch.

Table 5.1. Catalogue/Reference Numbers and Provenience of Projectile Point Sample from the Sheguiandah Site.

Catalogue/Reference Number	Identification (This paper)	Provenience
Tips (6)		
1- 1957-4-10	Plano	Level III
2- O Ma 1-1514.1	?	St. 7-9; 4¼ inches
3- O Ma 1-948	?	St. 7-1; 5½ to 6 inches
4- O Ma 1-1483.1	Plano	St. 7-9; 8 inches; Level IV
5- 1955-30-2	?	Habitation area
6- 1955-30-3	?	Habitation area
Mid-sections (3/4)		
1- O Ma 1- (cat. # unknown)	Plano	St. 7-13SW; 3 inches (transition)
2- O Ma 1-2051	Plano	St. 7-1; on till in transitional unit; 4½ inches
3- O Ma 1-1154	Plano	St. 7-8; 4 1½ inches
4- 1954-35-2/possibly O Ma 1-1154		
Blade with portion of haft element (1)		
1- O Ma 1-1529	?Plano	St. 7-9; 5 inches
Unstemmed lanceolate (14/15)		
1- O Ma 1-515/211	Plano	St. 7-5; 9 inches/ 2½ inches
2- 955.161.236	?	not from Level III
3- 1957-4-9	Plano	Level III
4- 955.161.226	Plano	St. 7-10(?); Level III; 4½ to 5½ inches
5- 955.161.237	?Plano	St. 7-8(?); Level III; 6½ (?) inches
6- 955.161.231	Plano	Level III
7- O Ma 1-259	?Plano	St. 7-3; 4½ inches
8- O Ma 1-290	Plano	St. 7-2; 1 inch
9- VIII-F:32507b	Plano	no provenience given; Robert Bell collection (gift of J. Notman, 1877)
10- 1954-35-1/possibly O Ma 1-259	?	St. 7-3, 4 or 5; 5 to 6 inches
11- 1954-35-3	?	Habitation area
12- 1955-30-4	Plano	St. 7-7; no exact depth given
13- 1955-30-5	?	St. 7-7; no exact depth given
14- O Ma 1-2091	Plano	St. 6-B; no exact depth given
15- O Ma 1-2109	?Plano	St. 7-12; no exact depth given
Stemmed lanceolate (3)		
1- 1954-35-4	Plano	St. 7-3, 4 or 5; 5 to 6 inches
2- 955.161.241	Plano	Level III
3- 955.161.238	Plano	St. 7-8; 6 inch level
Stemmed with triangular blade (2)		
1- O Ma 1-1778 (1957-4-2)	post-Plano	TP 4; not from Level III; 2 inches
2- 1955-30-1	post-Plano	4 inches
Side-notched (7)		
1- 1957-4-1	post-Plano	Level III
2- O Ma 1-1566	Plano/Early Archaic	St. 7-10; Level III; 10 inches
3- O Ma 1-1527	Plano/Early Archaic	St. 7-9; Level III; 6½ inches
4- O Ma 1-1154/ VIII-F:32507a	post-Plano	St. 7-8; 4½ inches
5- 1954-35-6	Plano/Early Archaic	St. 7-3, 4 or 5; 5 to 6 inches
6- 1955-30-7	Plano/Early Archaic	St. 7-1; 10 inches (bottom of pit)
7- O Ma 1-2135	Plano/Early Archaic	St. 7-12; no exact depth given

Table 5.1 (continued).

Catalogue/Reference Number	Identification (This paper)	Provenience
	Corner-notched (2/3)	
1- O Ma 1-155	?post-Plano	U.T.S.; Level III
2- 1957-4-3	?post-Plano	?
3- 1954-35-5/possibly O Ma 1-155		

Notes to Table 5.1

Reference/catalogue numbers:

- 1954-35-5, 1957-4-10 etc.: used if catalogue number not available; refers to date of publication, figure number and illustration number, respectively, in publication by Lee. A standard citation for the first number given as an example would read Lee, 1954, Figure 35, number 5.
- Ma 1- 948 etc.: field catalogue number used by Lee-- O (Ontario), Ma (Manitoulin Island), 1 (site number for Sheguiandah) followed by object number.
- 955.161.237: Royal Ontario Museum catalogue number, giving date of acquisition (955 meaning 1955), lot or group number of the acquisition and the individual number of a particular artifact.
- VIII-F:320507b: meaning unknown.

Provenience:

- all depths are as reported by Lee in inches below the surface
- St. 7-3, St. 7-4 etc: Station (excavation unit in Habitation area)
- St. 7-13SW: southwest
- transition: zone between Levels II and III
- TP 4: test pit 4
- U.T.S.: Thomas Lee designation; meaning unknown.

- *base*: thinned by the removal of short flakes, either variably spaced or in a short contiguous series, by knapping directed at the base. These flake removals may truncate flake scars produced by earlier knapping directed from the lateral margins of the specimen or they may themselves be truncated by later flaking directed from the lateral margins. The nature and extent of thinning may vary on opposite faces. For example, on one specimen (ROM 955.161.231; Figure 5.2, number 6) the margin of the base on one face was thinned by the removal of a single large conchoidal flake roughly 10.0 mm long and, subsequently, by several smaller flakes up to 7.0 mm long from both sides of this scar. In contrast, the margin of the base on the opposite face was thinned by the removal of a contiguous series of flakes, the scars of which were later truncated by flaking directed from the lateral margins of the specimen, leaving only portions of the negative bulbs from the earlier thinning process. Despite the variation in the nature and extent of basal thinning on both faces, the base of this specimen is symmetrical in cross-section. Other specimens exhibiting different patterns of unequal flaking on opposite faces (the most extreme example having been thinned on only one face) also tend to have symmetrical bases in cross-section. Thus, the achievement of a symmetrical base was clearly more important than the method used to produce it.

- *lateral/basal grinding*: often absent; if present, may be limited to the base and/or one lateral margin.

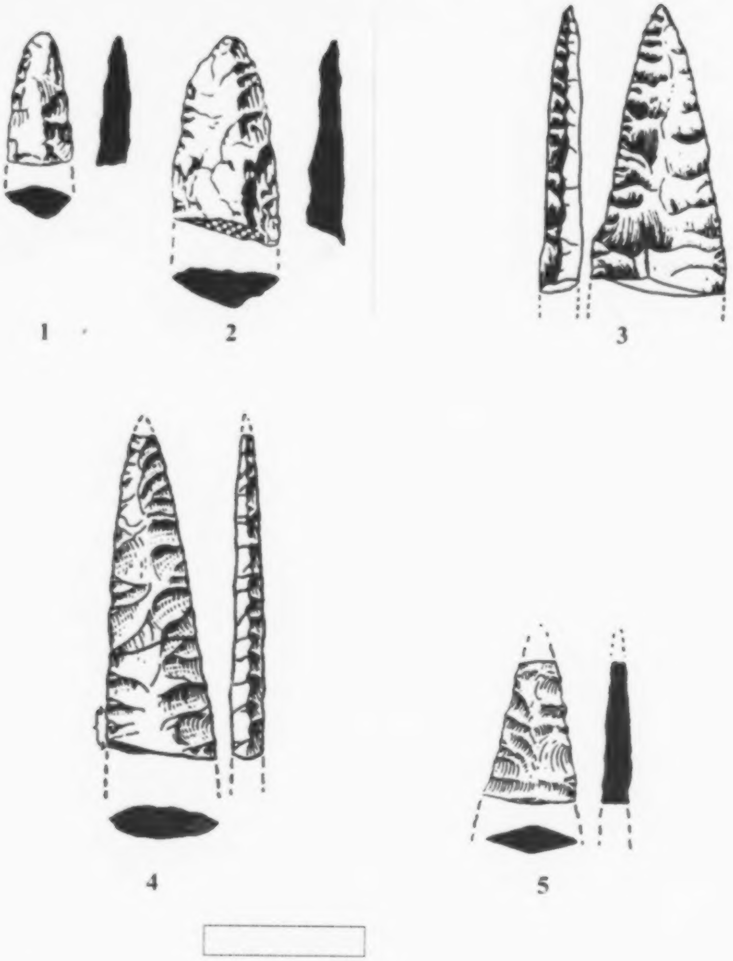
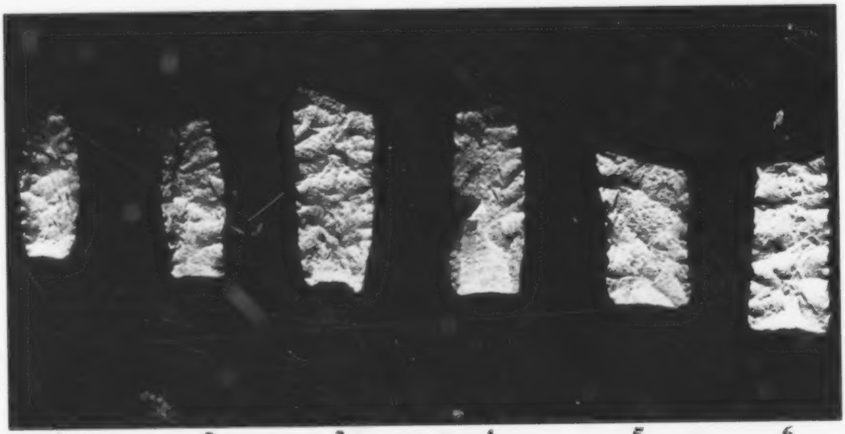


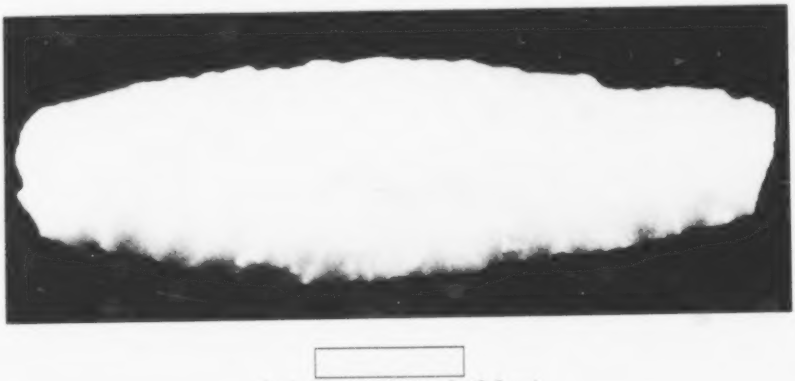
Figure 5.1. Projectile point tips and mid-section illustrated by Lee.
(scale bar equals 1 inch or 2.5 cm)
1- Lee 1955: Figure 30, number 2
2- Lee 1955: Figure 30, number 3
3- Lee 1957: Figure 5, number 8
4- Lee 1957: Figure 4, number 10
5- Lee 1954: Figure 35, number 2



(scale not available)

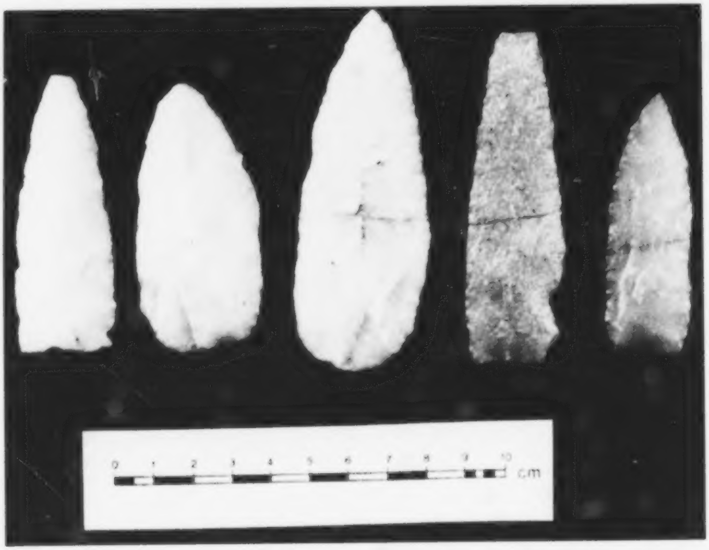
Figure 5.2. Unstemmed and stemmed lanceolate projectile points in the collections of the Royal Ontario Museum (individual artifact numbers below all prefixed by the number 955.161.)

1- 237 (see also Lee, 1957, Figure 4, number 8)
2- 238 (Lee, 1955, Figure 30, number 6)
3- 226 (Lee, 1957, Figure 4, number 12)
4- 236 (Lee, 1957, Figure 4, number 7)
5- 241 (Lee, 1957, Figure 4, number 14)
6- 231 (Lee, 1957, Figure 4, number 13)



Scale: Bar equals 1 inch. (2.5 cm)

Figure 5.3. Unstemmed lanceolate projectile point (VIII-F:32507b)



(Scale in centimetres)

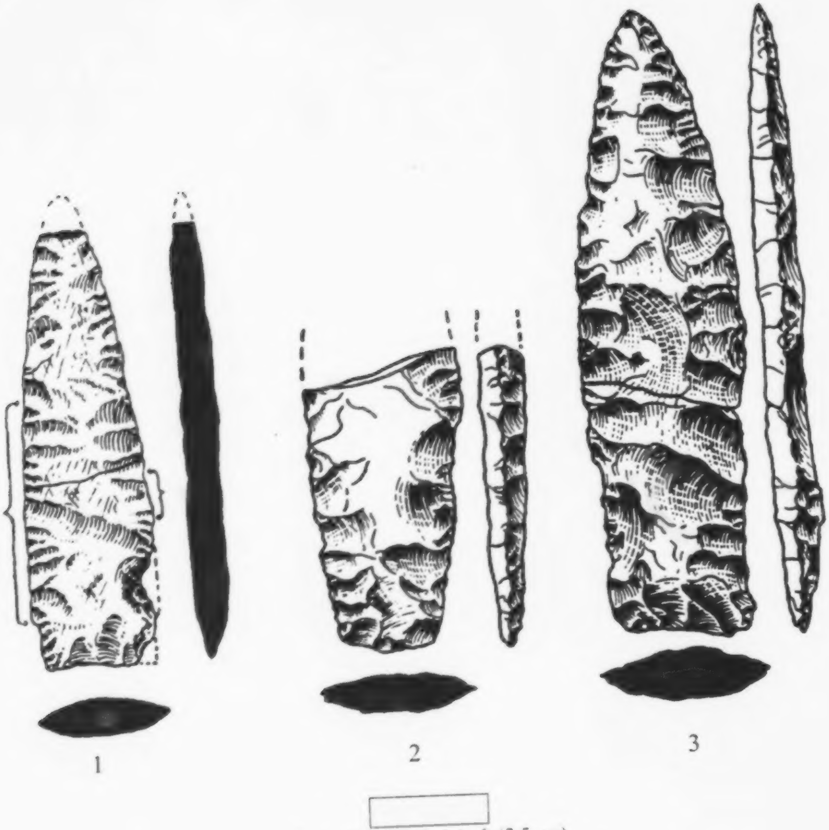
Figure 5.4. Projectile point mid-section and unstemmed lanceolate points (from left) *Mid-section*, 1- O Ma 1- (catalogue number unknown); *Unstemmed lanceolates*, 2 – O Ma 1- 569, 3 – O Ma 1 – 886/976, 4 - O Ma 1-515/211, 5 - O Ma 1-259

Plano/Early Archaic

A total of five specimens are tentatively classified as Plano/Early Archaic in cultural affiliation (Table 5.1; Figure 7, numbers 1, 2 and 7; Figure 5.8, numbers 2 and 4). Unfortunately, only two specimens were available for study, both basal fragments. The tangs below the notches are squarish, 7.0 to 8.0 mm long below the notches, somewhat rounded on the proximal corners and have straight bases which are lightly to heavily ground. The notches are U-shaped, 2.0 to 3.0 mm in width and depth and are oriented slightly obliquely to the long axis of the specimen. Both artifacts appear to have been extensively re-sharpened and, during their last phase of use, both were also badly damaged by impact fractures.

The three specimens unavailable for study are complete, although one (Figure 5.7, number 1) appears to have been conjoined from two fragments. These specimens also have squarish tangs (although with less evident rounding of the proximal corners) U-shaped notches and slightly concave bases. The blade of one specimen (Figure 5.7, number 2) is parallel-sided with a "blunted" tip, possibly the result of resharpening. The two other specimens (Figure 5.7, numbers 1 and 7) have slightly convex blade margins converging gradually toward the tip.

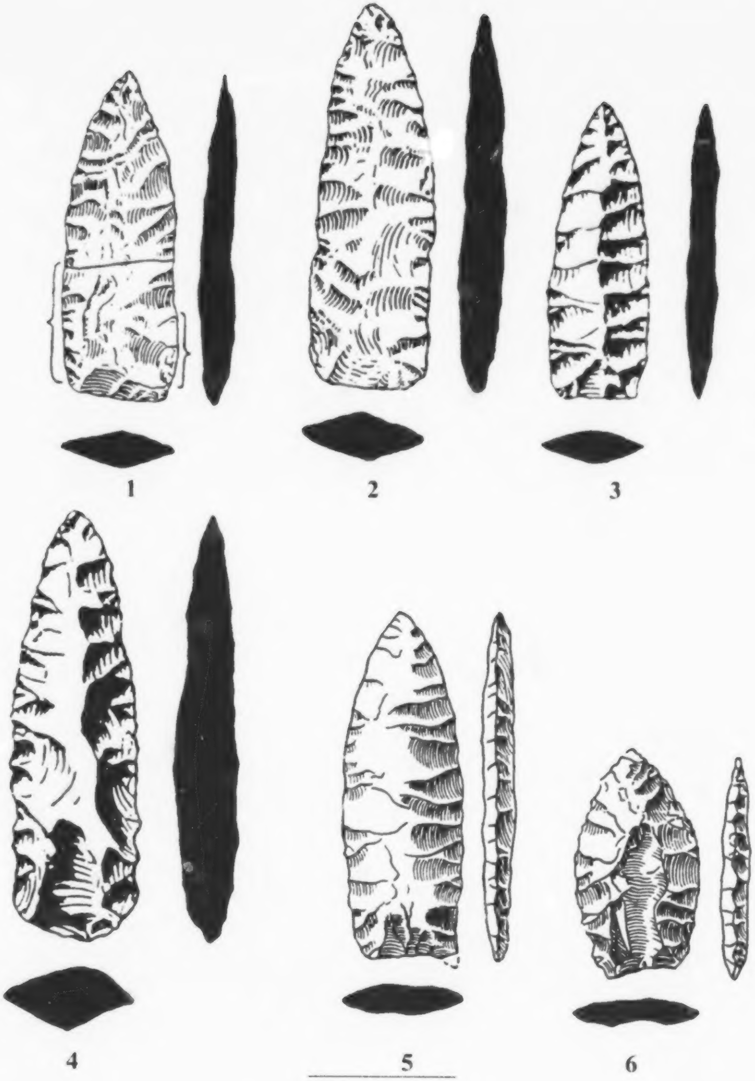
Interestingly, unlike the lanceolate and stemmed Plano points which were made primarily from quartzite, only one of the points in the Plano/Early Archaic group was made of quartzite, the other four being made of chert imported to the site or from other (as yet unidentified) material (see Table 5.1).



Scale: Bar equals 1 inch (2.5 cm)

Figure 5.5. Unstemmed and stemmed lanceolate projectile points illustrated by Lee. *Unstemmed*, 2- Lee, 1957, Figure 4, number 4; *Stemmed*, 1- Lee, 1954, Figure 35, number 9; 3- ROM 955.161.241 (Lee, 1957, Figure 4, number 14; see also Figure 2, number 5, this paper; blade/tip section not located)

The configuration of the base on these specimens (particularly the squarish tangs and U-shaped notches) is reminiscent of a side-notched point tightly associated with Eden and Scottsbluff points deposited with a cremation burial at the Renier site in east-central Wisconsin (Mason and Irwin, 1960). Broadly similar side-notched points are also reported from a Late Paleoindian bison-kill in north-western Iowa (Agogino and Frankforter 1960). Nearer to Sheguiandah, a side-notched point, together with the bases of two Eden / Scottsbluff-like points, was recovered from the George Lake I site (Greenman and Stanley 1943; for a photograph of the artifacts see Fitting, 1970, Figure 20, p. 60). This site is located several kilometres inland



Scale: Bar equals 1 inch (2.5 cm)

Figure 5.6. Unstemmed lanceolate projectile points illustrated by Lee. 1- Lee, 1954, Figure 35, number 3; possibly specimen catalogued as O Ma 1-259; 2 - Lee, 1954, Figure 35, number 1; 3- Lee, 1955, Figure 30, number 4; 4 - Lee, 1955, Figure 30, number 5; 5- not previously published, O Ma 1-2091; 6- not previously published, O Ma 1-2109

from the North Channel separating Manitoulin Island from the mainland, and a straight-line distance of approximately 30 kilometres northeast of Sheguiandah. Although the contextual relationship of the stemmed and side-notched points is not clear at the George Lake site, no artifacts clearly diagnostic of post-Paleoindian cultures were recovered from the site. This strengthens the argument that some of the side-notched points at Sheguiandah were made by Late Paleoindian people who, judging from the stemmed points they made (as well as other artifacts), were also clearly affiliated with those at George Lake. It should be noted, however, that typologically comparable side-notched points (with U-shaped side-notches located slightly oblique or perpendicular to the long axis of the specimen and located several millimetres above the base producing a pronounced, squarish tang) were also made by Early and Middle Archaic peoples in the mid-continent region, such as Graham Cave side-notched (Logan 1952), Raddatz side-notched (Wittry 1959a and 1959b) and related forms (see Justice 1987). Clearly, side-notched points with prominent tangs and U-shaped notches were made over a long period of time and, because they were not found in direct association with the Late Paleoindian material at Sheguiandah, the few specimens from that site will remain temporally and culturally ambiguous.

Projectile Points of Archaic and Later Cultural Affiliation

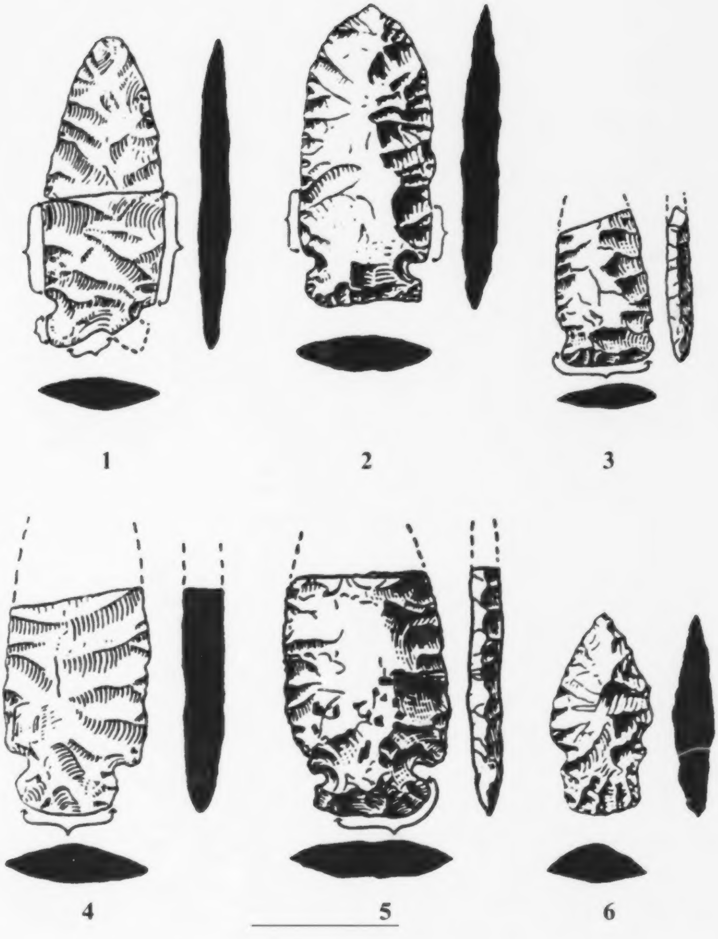
A total of 6/7 artifacts are classified as post-Plano (i.e. later Archaic or Woodland) in cultural affiliation (Table 5.1). [Note: one specimen in this group, 1954-35-5, may not represent a separate artifact]

The two stemmed points with triangular blades and two of the seven side-notched points are assumed to be Archaic or later in cultural affiliation because they exhibit post-Paleoindian technological attributes: on the stemmed points, small triangular blades (1955-30-1, Figure 5.7, number 6; and O Ma 1-1778, Figure 5.8, number 3) and, on the side-notched points, small V-shaped notches close to the base (1957-4-1, Figure 5.7, number 3) or irregular-shaped notches of unequal size and distance from the base (O Ma 1-1154/VIII-F:32507a, Figure 5.8, number 1). The latter artifact also exhibits irregular facial flaking with scars of highly uneven size, shape and extent across the face and numerous high spots ("islands") left by prominent step-fractures.

Finally, the cultural affiliation of both corner-notched points is enigmatic (Table 5.1). On one specimen (O Ma 1-155, possibly the specimen illustrated in Lee, 1954, Figure 35, number 5, and reproduced here in Figure 5.7, number 4) the facial flaking is reminiscent of a Late Paleoindian pattern: parallel, collateral flaking with even-sized, rectangular flake scars, although both faces don't exhibit this pattern to the same extent. Unfortunately, the second specimen (1957-4-3; Figure 5.7, number 5) could not be directly examined and the drawing by Lee is not detailed enough to show the pattern of facial flaking which might be helpful in determining cultural affiliation.

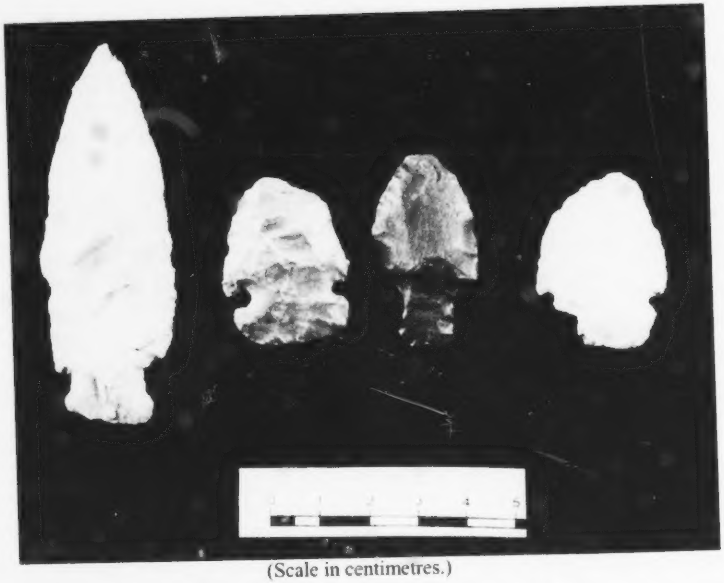
Distribution of Projectile Points on the Site

Unfortunately, provenience data for some of the projectile points has been lost (or not as yet found in the catalogues and notes). For those specimens that have provenience data, all appear to be from that part of the site Lee referred to as the Habitation area. In this area, Lee states that all of the projectile points occurred at about the same depth in Level III, a "transition"



Scale: Bar equals 1 inch (2.5cm)

Figure 5.7. Notched and stemmed projectile points illustrated by Lee
Side-notched: 1- Lee, 1954, Figure 35, number 6; 2- Lee, 1955, Figure 30, number 7; 3- Lee, 1957, Figure 4, number 1; *Corner-notched*: 4- Lee, 1954, Figure 35, number 5; 5- Lee, 1957, Figure 4, number 3; *Stemmed with triangular blade*: 6- Lee, 1955, Figure 30, number 1



(Scale in centimetres.)

Figure 5.8. Photograph of notched and stemmed projectile points illustrated by Lee *Side-notched*: 1- O Ma 1-1154 (VIII-F:32507a), 2- O Ma 1-1566, 4- O Ma 1-1527; *Stemmed with triangular blade*: 3- O Ma 4-1778

zone located between five and six inches below the surface and identified by a different soil colour as well as by artifact content. With respect to other strata, Level III occurred "...on top of the glacial deposits [beginning with Level IV] but below the large bifaces of Level II..." (Lee 1957, p. 121). Lee also says that "...it is difficult to consider them [the projectile points] as a single component..." because typologically they reflect a broad span of time (Ibid, p. 121).

Provenience data in Table 5.1 shows that the projectile points occurred over a much greater vertical range that Lee's generalized stratigraphic sequence suggests: between one and 10 inches below surface, spanning Levels II and III. Lee reports that one specimen, a side-notched point recovered at a depth of 10 inches below surface, occurred in the bottom of a former pit. As noted above, Lee clearly recognized that typologically distinct point types, made over a broad span of time, were mixed together in the upper portion of the site. What is noteworthy here is that the vertical distribution of projectile points overlaps Level II which, because of the occurrence of "large primary bifaces", Lee thought was distinct from the underlying Level III with its projectile points. The provenience data in Table 5.1, however, casts doubt on Lee's distinction between Levels II and III. The implications of these and other stratigraphic data have been considered in greater detail in the previous chapter 4 (Julig and Mahaney, this volume).

Inter-Regional Comparisons

As previously mentioned, the Late Paleoindian points from Sheguiandah exhibit several technological attributes that are commonly found on a number of Late Paleoindian (Plano) point types in western North America where Late Paleoindian cultures were first discovered. However, several specimens from Sheguiandah suggest more specific typological affinities. For example, the rounded base (and thus bi-pointed outline) of specimen VIII-F:32507b (Figure 5.3) is reminiscent of Agate Basin points, such as represented at the type site in east-central Wyoming (Frison and Stanford 1983). Secondly, the elongated tip with diamond-shaped cross-section on specimen 1957-4-10 (Figure 5.1, number 4), the cross-section on specimen O Ma 1-515/211 (Figure 5.4, number 2), ranging from lenticular at the base to diamond-shaped at the tip (also present on specimen VIII-F:32507b mentioned earlier) and the slight stems on the three stemmed lanceolates (1954-35-4, Figure 5.5, number 2; ROM 955.161.238, Figure 5.2, number 2; and ROM 955.161.241, Figure 5.2, number 5, and Figure 5.5, number 3) are reminiscent of some points in the Alberta and Cody complexes (Agenbroad 1978; Frison and Todd 1987; Irwin-Williams et al., 1973). [Note: the basal specimen catalogued as ROM 955.161.241 is shown in Lee's drawing-- reproduced in Figure 5.5, number 3-- as two conjoined fragments; unfortunately, the blade/tip fragment was not located for this study.] Finally, one basally thinned lanceolate specimen (ROM 955.161.226, Figure 5.2, number 3) is, as Lee reported, reminiscent of some Plainview specimens in overall outline and general pattern of facial flaking (see Hartwell 1995 and sources cited therein).

The comparisons cited above are interesting, but also risky considering the huge geographic distribution and presumed range of variation of Agate Basin, and ongoing arguments over the definition, stratigraphic occurrence and age of parallel-sided, concave base points such as Plainview, Goshen (or Goshen-Plainview) and Midland, to name but three. In addition, there is the problem of small sample size at Sheguiandah and, of course, the long distances between northern Lake Huron and the north-western and southern Plains. These comparisons do, however, underscore the general Late Paleoindian cultural affiliation of many of the unstemmed and stemmed points from Sheguiandah and, ultimately the western origin of the people who occupied the site.

Between Sheguiandah and the High Plains, several other Late Paleoindian complexes have been defined. These include: the Lakehead Complex in north-western Ontario (see, for example, Julig 1994), the Flambeau and Minocqua phases in northern Wisconsin (Salzer 1974), the Reservoir Lakes Complex in northern Minnesota (Harrison et al. 1995) and the Sister's Hill phase and Caribou Lake Complex in south-eastern Manitoba (Pettipas 1976; Pettipas and Buchner 1983; Steinbring and Buchner 1980). All are characterized by unstemmed or stemmed lanceolate points of Late Paleoindian cultural affiliation. And clearly, all represent a movement of people from west to east, around both sides of the upper Great Lakes and into the mid-continent region. The Late Paleoindian occupation at Sheguiandah is clearly an eastern extension of that movement around the top of the lakes; a movement which, to be fully understood in a regional context, needs yet to be better dated and related to both strategies of human adaptation and post-glacial environmental change.

Acknowledgments

I would like to thank Patrick Julig for access to the Sheguiandah material he borrowed from the Canadian Museum of Civilization, for making available for use in this paper several photographs he took of Sheguiandah projectile points and for providing catalogue information and copies of Thomas Lee's unpublished drawings of three "rediscovered" points. I would also like to thank Robert Lee for initially providing the drawings that Julig made available to me. Neither individual, of course, is responsible for the way in which I put the material together or described and interpreted it. The photograph used in Figure 5.2 was taken by William Robertson, former photographer at the Royal Ontario Museum, and is used courtesy of the ROM. The various line drawings published by Thomas Lee and used in several of the figures in this paper were taken from publications cited in the text and reassembled into the figures presented here.

Finally, I would like to thank the Township of Howland, Ojibwas of Sucker Creek, the Sheguiandah First Nation and Ronald F. Williamson of Archaeological Services Inc. (Toronto) for making possible the reinvestigation of the Sheguiandah site in 1991, and ultimately this book.

References

Agenbroad, L.D., editor. 1978. *The Hudson-Meng Site: An Alberta Bison-Kill in the Nebraska High Plains*. University Press of America, Washington, D.C.

Agogino, G.A. and W.D. Frankforter. 1960. A Paleoindian Bison Kill in Northwestern Iowa. *American Antiquity* 25(3): 414-415.

Fitting, J.E. 1970. *The Archaeology of Michigan: A Guide to the Prehistory of the Great Lakes Region*. Garden City, New York: The Natural History Press.

Frison, George C. 1991. The Goshen Paleoindian Complex: New Data for Paleoindian Research. In *Clovis Origins and Adaptations*, edited by R. Bonnichsen and K.L. Turnmire, pp. 131-151. Corvallis: Oregon State University, Center for the Study of the First Americans.

Frison, George C. 1996. *The Mill Iron Site*. Albuquerque: University of New Mexico Press.

Frison, George C. 1988. Goshen Complex. *Archaeology of Prehistoric Native America: An Encyclopedia*, edited by Guy Gibbon, pp. 317-318. New York: Garland Publishing Company.

Frison, G.C. and D.J. Stanford. 1982. *The Agate Basin Site: a record of the Paleoindian occupation of the Northwestern High Plains*. New York: Academic Press.

Frison, G.C. and L. C. Todd. 1987. *The Horner Site: the type site of the Cody cultural complex*. New York: Academic Press.

Greenman, E.F. and G.M. Stanley. 1943. The Archaeology and Geology of Two Early Sites Near Killarney, Ontario. *Papers of the Michigan Academy of Science, Arts, and Letters* 28: 505-531.

Harrison, C., E. Redepenning, C.L. Hill, G.Rapp, Jr., S.E. Aschenbrenner, J.K. Huber and S.C. Mulholland. 1995. The Paleoindian of Southern St. Louis County, Minnesota: the Reservoir Lakes

Complex. *Interdisciplinary Archaeological Studies*, University of Minnesota, Monograph Series, Number 4.

Hartwell, W.T. 1995. The Ryan's Site Cache: Comparisons to Plainview. *Plains Anthropologist* 40(152): 165-184.

Irwin-Williams, C., H.T. Irwin, G. Agogino, and C.V. Haynes, Jr. 1973. Hell Gap: Paleoindian Occupation on the High Plains. *Plains Anthropologist* 18(59): 40-53.

Julig, P.J. 1994. The Cummins Site Complex and Paleoindian Occupations in the Northwestern Lake Superior Region. *Ontario Archaeological Reports 2*, Ontario Heritage Foundation, Toronto.

Justice, N.D. 1987. *Stone Age Spear and Arrow Points of the Midcontinental and Eastern United States: A Modern Survey and Reference*. Bloomington and Indianapolis: Indiana University Press.

Logan, W.D. 1952. *Graham Cave: An Archaic Site in Montgomery County, Missouri*. Missouri Archaeological Society Memoir Number 2.

Lee, T.E. 1954. The First Sheguiandah Expedition, Manitoulin Island, Ontario. *American Antiquity* 20(2): 101-111.

Lee, T.E. 1955. The Second Sheguiandah Expedition, Manitoulin Island, Ontario. *American Antiquity* 21(1): 63-71.

Lee, T.E. 1957. The Antiquity of the Sheguiandah Site. *The Canadian Field Naturalist* 71: 117-131.

Mason, R.J. and C. Irwin. 1960. An Eden-Scottsbluff Burial in Northeastern Wisconsin. *American Antiquity* 26(1): 43-57.

Pettipas, L.F. 1976. Environmental Change and Cultural Dynamics During the Paleoindian Period with Special Reference to Manitoba. In *Papers in Manitoba Archaeology*, Misc. Papers No. 1, pp. 20-40. Winnepeg: Manitoba Historic Resources Branch.

Pettipas, L.F. and A.P. Buchner. 1983. Paleoindian Prehistory of the Glacial Lake Agassiz Region in Manitoba, 11,500-6,500 B.P. In *Glacial Lake Agassiz*, edited by J.T. Teller and L. Clayton, pp. 421-451. Geological Association of Canada, Special Paper 26.

Salzer, R.J. 1974. The Wisconsin North Lakes Project: a preliminary report. In *Aspects of Upper Great Lakes Anthropology: Papers in Honor of Lloyd A. Wilford*, edited by E. Johnson, pp. 64-73. Minnesota Historical Society, Minnesota Prehistoric Archaeology Series, No. 11.

Steinbring, J.H. and A.P. Buchner. 1980. The Caribou Lake Complex: a provisional definition. In *Directions in Manitoba Prehistory: Papers in Honour of Chris Vickers*, edited by L. Pettipas, pp. 22-35. Winnipeg: Association of Manitoba Archaeologists and Manitoba Archaeological Society.

Wittry, W.L. 1959a. The Raddatz Rockshelter SK 5, Wisconsin. *The Wisconsin Archeologist* 40: 33-39.

Wittry, W.L. 1959b. Archaeological Studies of Four Wisconsin Rockshelters. *The Wisconsin Archeologist* 40(4): 137-267.

Chapter 6

Quaternary Geology, Stratigraphy and Sedimentology of the Sheguiandah Site

Peter J. Barnett

Abstract

The landscape around Sheguiandah is strongly bedrock controlled. Ice flowed toward the south-southwest depositing till whose properties strongly reflect the underlying bedrock geology. During deglaciation, a large proglacial lake formed along the receding ice margin in the Georgian Bay and Lake Huron basins (glacial Lake Algonquin). Several phases (different water levels) of glacial Lake Algonquin existed during recession as different outlets were uncovered, eroded and isostatically uplifted. Many of these phases left shoreline deposits and features in the Sheguiandah area. Soil formation and post-glacial weathering has altered the appearance and properties of the glacial and glaciolacustrine sediments. Coarser sediments, such as ancestral beach and near-shore sediments, have become finer grained within the soil profile.

The sediments exposed in the trenches in the Sheguiandah Site Habitation area record an environmental change from a subglacial-ice marginal environment to proglacial lake environment to eventual subareal exposure of the site. Overall sediment facies transitions record a lowering of lake levels up until the site was exposed to post-glacial weathering processes. The sediments referred to and identified as till 1 and 2 by Thomas Lee are probably not tills. They are not debris flows either, as suggested by Hough. These sediments of questionable origin are most likely highly oxidized and weathered nearshore or beach deposits of a postglacial lake, probably the Korah phase of glacial Lake Algonquin. The distribution of artifacts throughout these shoreline deposits suggests contemporary existence of Paleoindians with the Korah phase water levels.

Résumé

Autour de Sheguiandah, le paysage est largement dominé par le socle rocheux. Le glacier s'écoulait vers le sud-ouest en déposant du till dont les propriétés reflètent beaucoup la géologie du socle rocheux sous-jacent. Pendant la déglaciation, un grand lac proglaciaire s'est formé le long de la marge glaciaire en recul dans les bassins de la baie Georgienne et du lac Huron (le lac glaciaire Algonquin). Pendant les reculs glaciaires, le lac glaciaire Algonquin a subi plusieurs phases (niveaux d'eau différents) créant ainsi des dégorgeoirs alors découverts, érodés et relevés par le mouvement isostatique. Beaucoup de ces phases ont laissé des dépôts et des caractéristiques sur les berges de la région de Sheguiandah. La pédogenèse et l'altération atmosphérique après la période glaciaire ont modifié l'apparence et les propriétés des sédiments glaciaires et glaciolacustres. Des sédiments grossiers, comme les sédiments des plages anciennes et du littoral, se sont affinés dans le sol.

The Sheguiandah Site: archaeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario, edited by P. Julig. Canadian Museum of Civilization, Archaeological Survey of Canada, Mercury Series Paper 161, 2002.

Les sédiments exposés dans les tranchées de la zone d'habitation du site de Sheguiandah témoignent d'un changement où l'environnement marginal est passé de sous-glaciaire marginal à un environnement de lac proglaciaire pour exposer, en bout de ligne, la zone subaérienne du site. Dans l'ensemble, les transitions du faciès des sédiments révèlent un abaissement du niveau des lacs jusqu'à ce que le site soit exposé au processus d'altération atmosphérique post-glaciaire. Ces sédiments, appelés till 1 et 2 par Thomas Lee, ne sont probablement pas des tills, pas plus que des coulées de débris comme l'a suggéré Hough. Ces sédiments d'origine douteuse sont probablement des substances très oxydées et altérées par le temps, déposées sur le littoral ou les plages d'un lac post-glaciaire correspondant sans doute à la phase Korah du lac glaciaire Algonquin. La répartition des artefacts dans ces dépôts riverains suggère que des Paléoindiens vivaient dans les marges fluctuantes de l'eau.

Introduction

Quaternary geology is the study of the earth's history during the Quaternary Period or the last 1.8 million years. The Quaternary Period is generally considered a time when the earth's climate was cool and when large parts of North America and Europe were intermittently covered by large continental ice sheets. The first part of this chapter summarizes some of the features (geomorphology) and deposits (geology) that were laid down during the Quaternary in the vicinity of Sheguiandah and sets the background for later interpretations on the origin of the sediments that enclose the artifacts at this significant archaeological site.

Much controversy surrounds the origin of the encasing sediments and the age of the artifacts at the Sheguiandah site. The sediments containing the artifacts on Levels IV and V, have been interpreted as till by Thomas E. Lee, the original archaeologist at the site. He reports, in an article entitled "Sheguiandah and early man" published in 1978, that several distinguished geologists and Quaternary geologists had visited the site and supported this interpretation; including Dr. Ernst Antevs, (who did not actually visit the site). Lee (1978) suggested that the artifacts and human occupation of this site date back before the last glacial advance in the area, possibly 30 000 years ago. Dr. Jack Hough, however, suggested that the sediment containing the artifacts were mudflows, not tills, and that the occupation of the site must have been after the draining of glacial Lake Algonquin (Lee 1978).

Regional geomorphology

The landscape in the vicinity of Sheguiandah is highly bedrock controlled. White rounded Precambrian quartzite ridges and high, steep escarpments composed of gently-dipping carbonate and clastic sedimentary rocks of Paleozoic age (Niagara Escarpment) dominate the landscape. Steps in the profiles of escarpment faces occur as the result of differential erosion and weathering of alternating harder and softer beds of rock. Both above and below the escarpments are gently dipping plains underlain by rocks of Paleozoic age.

Glacial and glacial meltwater (glaciofluvial) processes of erosion and deposition tend to smooth pre-existing landscapes. However, the resistant bedrock features at Shequiandah remain to dominate the landscape.

Large, broad, steep-walled valleys, such as the one in which Sheguiandah Bay and Bass Lake are located, are cut back into the face of the escarpments. They were probably carved initially by tributaries of the pre-glacial Laurentian River and enlarged during glaciation by the action of the ice and large subglacial floods of meltwater that carved the network of tunnel valleys and other significant meltwater erosion forms that occur across south-central Ontario (Barnett 1989, 1990, Shaw and Gorrell 1991, Brennand and Shaw 1994, Barnett *et al.* 1998).

There are several other landforms, the result of glacial and post-glacial activity, that make up the landscape around Shequiandah. These include: drumlins or streamlined hills associated with glaciers; abandoned beaches of ancestral post-glacial lakes; abandoned shore cliffs or bluffs (small escarpments cut into glacial sediments and/or bedrock by post-glacial lake waves); and lake plains underlain by fine-grained deposits of sand, silt or clay (ancestral lake bottom deposits).

Regional glacial and post-glacial deposits and features

The glacial deposits found on Manitoulin Island, like most of Ontario, are believed to be of Late Wisconsinan age or deposited during the last 25 000 years. Older deposits do exist in Ontario, but are rare and have limited distribution. On Manitoulin Island, glacial deposits generally form a thin and discontinuous cover over the bedrock surface. Till and various types of glacial lake deposits are the dominant sediments.

Bedrock commonly outcrops or is covered by a veneer (less than 1 m.) of glacial or post-glacial lake (glaciolacustrine) sediments. The bedrock plains were either areas of little or no deposition of glacial sediment or subsequently washed clean of glacial sediment by waves of the post-glacial Lake Algonquin. Sediment cover can be locally thick in the lower areas of the landscape, for example, in the re-entrant valley at Sheguiandah or within the drumlins of the area.

Several sets of glacial striations and grooves that occur on the bedrock surface, record the direction of former glacier movement. The most common are oriented between 200° and 220° N. On the western end of Manitoulin Island, striations are oriented toward 195 ° to 200 ° N. On Barrie Island, an older set of striations is oriented at 120 ° N (Chapman and Putnam 1984). The orientation of drumlins and large grooves cut into the bedrock surface (observed on air photographs) are between 220 ° and 240 ° N. Striations on quartzite outcrops on the northern edge of the Sheguiandah site are oriented approximately 230 ° N.

Drumlins on Manitoulin Island are generally long and thin, however some are cigar-shaped (Chapman and Putnam 1984). The drumlins are composed of till; a sediment "deposited directly by or from glacier ice with little or no reworking by water" (Dreimanis 1988). Till composition is quite variable between drumlin fields of the island and is closely associated with the underlying bedrock type. For example, clasts (stones) within the till near Tehkummah, are dominantly composed of acid Precambrian rock types; near Ice Lake, red shale clasts dominate; and at Silver Lake, the till clasts are almost entirely of dolostone and limestone (Chapman and Putnam 1984).

Locally, near the Sheguiandah site, this close relation of till composition to underlying bedrock type also exists. Not only the lithologies of the clasts, but the grain size distribution of the till's matrix (less than 2 mm size fraction of the till) is also different. Figure 6.1 shows the matrix grain size distribution of samples from till overlying carbonate and shale bedrock near Shequiandah, to which we can later compare the results of grain-size analyses of the sediments exposed at the Shequiandah site.

Till overlying carbonate bedrock approximately 5 km west of the Sheguiandah site, is dark brown to brown (10YR 4/3, 10YR 5/3), loose to compact, fissile, gritty, fine sandy silt. The matrix of the till (3 samples) averages 37% sand, 43% silt and 20% clay and all samples of the till are extremely poorly sorted (Figure 6.1). It contains between 5% and 10% clasts, ranging in size from granules to boulders. Some boulders are bullet-shaped and extensively striated. Pebble counts at two levels in the till contain high amounts of locally-derived clasts from the Georgian Bay, Bobcaygeon and Blue Mountain formations, with an increase in the proportion of Georgian Bay Formation clasts in the upper part of the exposed till. The till is interpreted as subglacial lodgement till (Figure 6.2).

Till overlying shale bedrock approximately 4 km north of the Sheguiandah site is olive (5Y 4/3), compact, blocky, clayey silt containing some very coarse sand grains and granules. One sample of the matrix of this till contains 14% sand, 51% silt and 35% clay and is extremely poorly sorted (Figure 6.1). Clast content is less than 1%, consisting of predominantly pebbles and cobbles; boulders are rare. Pebble are also derived locally, however, at this site over 80% of the clasts are derived from rocks of the Collingwood Member of the Lindsay Formation and the Blue Mountain Formation. The till matrix at this site is very local: derived primarily from the crushing of shales that it overlies. A sample of the shale bedrock contains 7.5% sand and 41% clay. The lower contact of the till with the underlying shale is difficult to find because of a zone of deformation till or glacially-deformed shale which, in places, can exceed 1.5 m in thickness. Only one till layer has been recognized on Manitoulin Island to date, with the exception of the multiple-till layers reported at the Sheguiandah site by Lee (1978).

As the margin of the glacier receded northward during deglaciation of the area, a large, proglacial lake formed up against the ice margin. This lake that occupied much of Georgian Bay, Lake Huron and Lake Michigan has been referred to as glacial Lake Algonquin (Spencer 1891, Eschman and Karrow 1985).

Glacial Lake Algonquin, submerged all of Manitoulin Island, with the exception of High Hill, east of West Bay following glaciation (Chapman and Putnam 1984). Abandoned shoreline features and deposits (beaches and bars of gravel and sand, and shore bluffs) are common and well preserved throughout the island. They record the post-glacial lake-level history of glacial Lake Algonquin. This lake consisted of several phases each with its own level (Figure 6.3). Fluctuations in lake levels have been attributed to: 1) a change in outlet or sill location (dependent on ice margin position); 2) a change in the level of the outlet as a result of down-cutting (erosion), or uplift (isostatic rebound); and 3) to a rapid input of water into the lake basin (floods; Lewis and Anderson 1989; Anderson and Lewis, this volume).

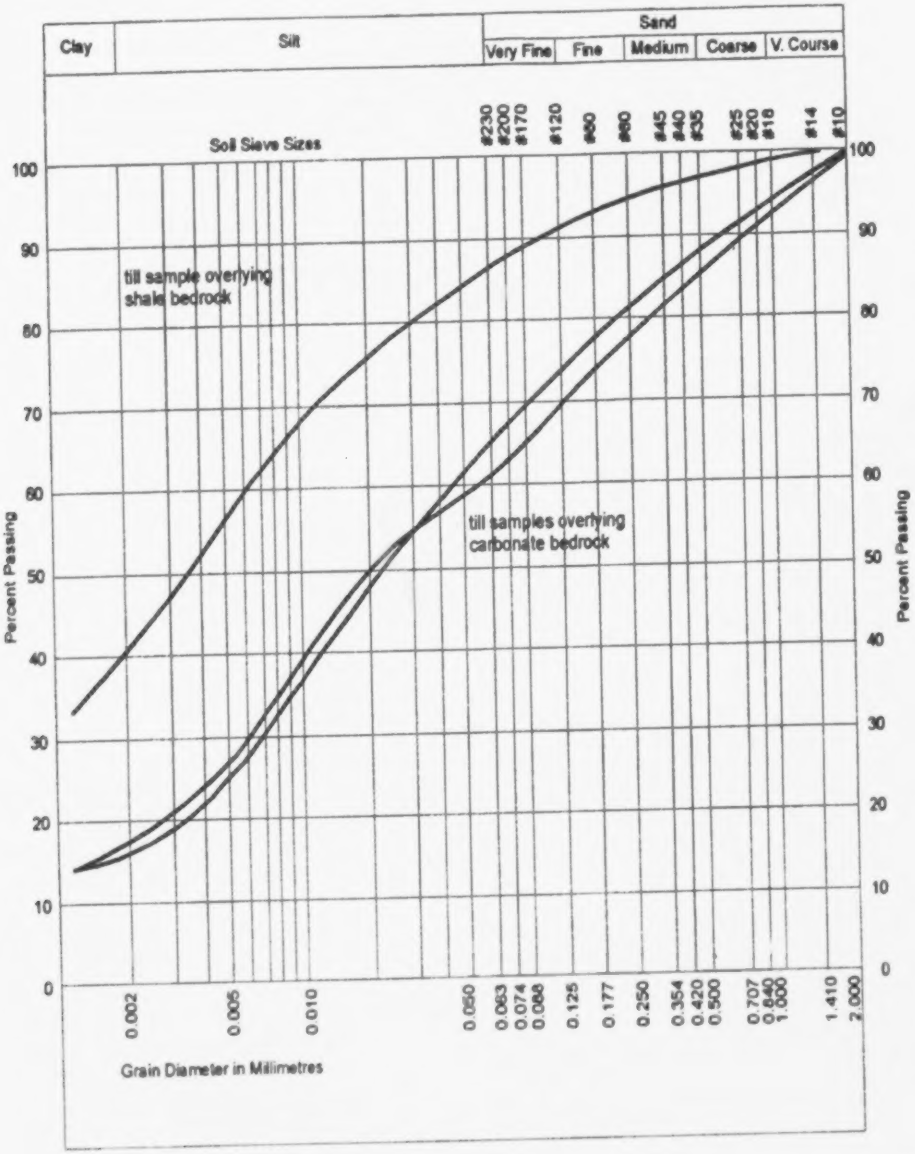


Figure 6.1. Matrix grain size distribution of off-site till samples.

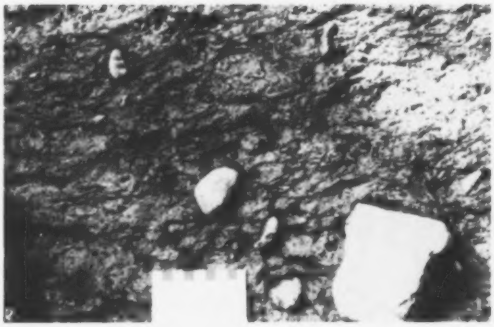


Figure 6.2. Compact, fissile, sandy silt till exposed west of the Shequiandah Site.

Abandoned shoreline features of most of the post-Main Algonquin phases of glacial Lake Algonquin are in the immediate vicinity of the Sheguiandah site (Sly and Lewis 1972). Lake basin deposits of sand, and varved silt and clay, occur in the low areas and drape the flanks of drumlins in the area (Chapman and Putnam 1984).

Samples of sand and gravel (glaciolacustrine near-shore sediments) were collected from the Ferguson Sand and Gravel Pit, approximately 3 km west northwest of the Sheguiandah site, for grain-size analysis. Two depositional shoreline environments were sampled, 1) a bay-mouth bar, and 2) the associated lagoon environment. In addition, samples were collected from several of the soil horizons present, to determine the effects of post-glacial weathering on gravel deposits in the Sheguiandah area. The results can be used later to compare to the results of on-site Sheguiandah Habitation area samples.

The bay-mouth bar, built during the Payette Phase of glacial Lake Algonquin, contains about 15 m of imbricated, clast-supported, boulder to cobble gravel interbedded with pebble gravel. Three samples were collected at various depths down through the soil profile and the resulting grainsize analysis of the matrix is presented in Figure 6.4a. The matrix of the C-horizon (100-105 cm depth) relatively un-weathered sample is predominantly a well-sorted, medium to coarse-grained sand (92% sand, 8% silt). Up through the soil profile the matrix becomes progressively poorer sorted and finer as the weathering processes break down and modify the parent material (30-35 cm depth: 76.5% sand, 23.5% silt; 10-15 cm depth: 59.5% sand, 40.5% silt).

A set of three samples was collected from the lagoon environment immediately behind the bay-mouth bar. The material exposed here was interbedded, silty medium to coarse-grained sand with rare pebbles and pebble gravel in a silty, coarse sand matrix. The matrix grain size curves (Figure 6.4b) all display a bimodal distribution with one mode in the medium to coarse sand-size fraction and the other in the coarse silt to very fine sand-size range. This bimodal distribution is to be expected because the sediment's depositional environment is affected by bay-mouth bar and lagoon sedimentary processes. Samples contain between 23% and 39% silt-sized particles or finer. Post-glacial weathering may have also affected particle size distribution.

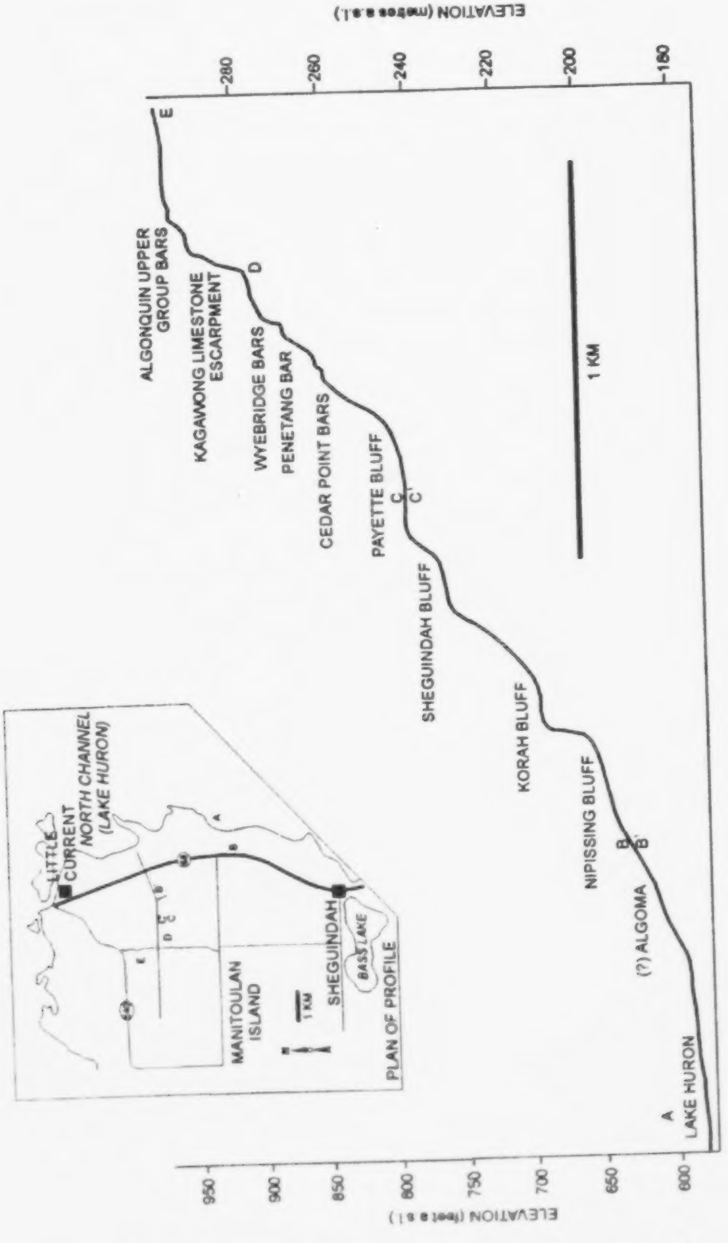


Figure 6.3 Present- day locations of post-glacial shorelines in the Sheguiandah area (after Sly and Lewis 1972).

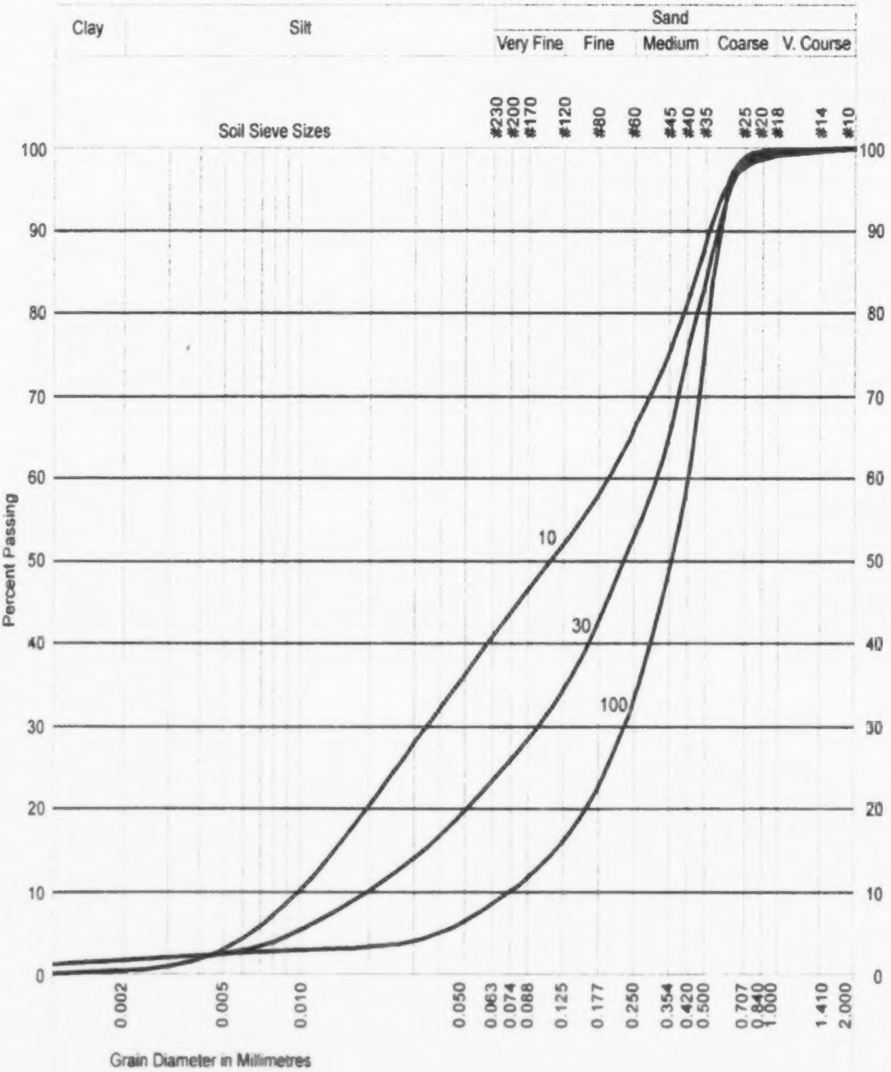


Figure 6.4a. Matrix grain size distribution of bay-mouth bar sediments (Shequiandah Phase). Numbers on curve indicate depth (cm) of sample from surface.

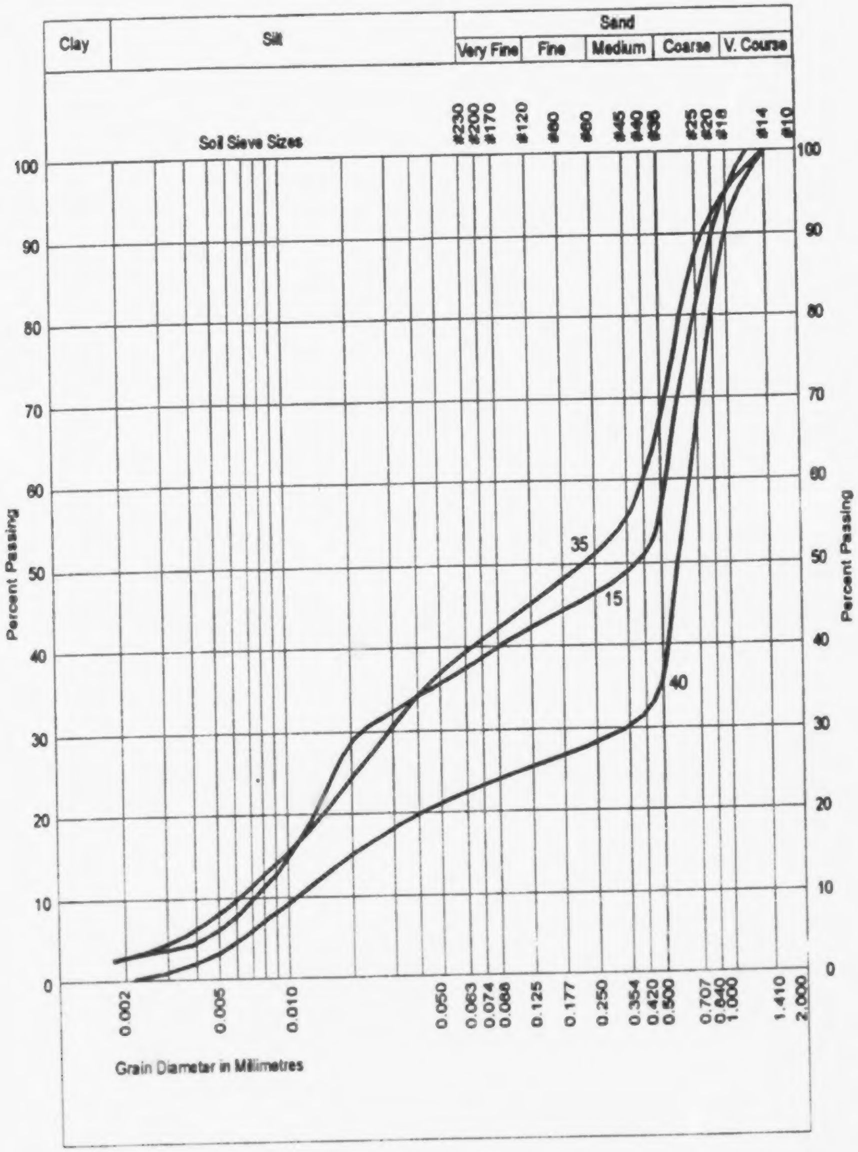


Figure 6.4b. Matrix grain size distribution of lagoon sediments (Sheguiandah Phase). Numbers on curves indicate approximate depth (cm) of sample from surface.

In summary, the landscape around Sheguiandah is strongly bedrock controlled. Ice flowed toward the south-southwest depositing till whose properties strongly reflect the underlying bedrock geology. During deglaciation, a large proglacial lake formed along the receding ice margin in the Georgian Bay and Lake Huron basins (glacial Lake Algonquin). Several phases (different water levels) of glacial Lake Algonquin existed during recession as different outlets were uncovered, eroded and isostatically uplifted. Some levels may correspond to glacial Lake Agassiz drainage events (floods, see Anderson and Lewis, this volume). Many of these phases left shoreline deposits and features in the Sheguiandah area. Soil formation and post-glacial weathering has altered the appearance and properties of the glacial and glaciolacustrine sediments. Coarser sediments, such as ancestral beach and near-shore sediments, have become finer grained within the soil profile.

Sheguiandah Archaeological Site: Stratigraphic and Sedimentologic Investigations of the Habitation Area

Introduction

The Sheguiandah site is located immediately north of the hamlet of Sheguiandah. The site consists of several small quartzite quarries and a habitation area situated on a bedrock-controlled hill (Figure 6.5). Important geomorphic features at the site include the hill of white quartzite, the "Mystic Ridge" and the Nipissing Great Lakes shorebluff. The white quartzite hill, where the quarries are located, probably formed the backbone of a small island at the time of occupation. The "Mystic Ridge" extends eastward from the southwest corner of the quartzite hill as a low narrow ridge. It is cored by cemented, quartzite boulders and interpreted as a beach of Ordovician age (von Bitter 1992; von Bitter, this volume). The ridge and hill surround a gently dipping plain where the habitation area and the test pits described below are located. The Nipissing Great Lakes shorebluff is a prominent feature that surrounds almost the entire island. Its elevation at about 198 m (650 ft.) provides a local datum for paleo-lake level correlation and reconstruction.

The present archaeology investigation was undertaken under the guidance of Drs. Patrick Julig and Peter Storck and Ron Williamson. It included: removing the backfill from the original trenches of Thomas Lee; excavating along the walls of Lee's original trenches; collecting and cataloging new found artifacts; re-surveying the site; and examining bedrock surfaces and quarry faces.

Dr. Peter von Bitter of the Royal Ontario Museum, investigated the bedrock geology of the site and surrounding area. Dr. Bill Mahaney of York University (Julig *et al.* 1994) analyzed grainsize distributions and grain textures using a scanning electron microscopy on samples collected previously by Thomas Lee (Julig and Mahaney, this volume). The author studied the sedimentology and stratigraphy of the Quaternary sediments at the site in order to determine their origin and age. It is this latter information that is reported on in the remainder of this chapter.

Sheguiandah Site Test Pits 7-8, 7-9 and 8-B

On-site investigation included the description and sampling of materials exposed in the re-excavated trenches of Thomas Lee (Test Pit 7-8, 7-9, and 8-B). Sketches of the sediments observed in the trenches are presented in figures 6.6, 6.7, and 6.8, and a description of the geological units and soil horizons present are summarized in Table 6.1. Emphasis is placed on the description and interpretation of the diamicton units that occur in various stratigraphic positions in the trench exposures, specifically the two "till" units identified by Lee (1978).

On-site diamictons

The lowermost unit in test pits 7-8 (SW) and 7-9 (W) (Figures 6.6, 6.7) is a mottled grey, brown and orange, matrix-supported diamicton. Its matrix is gritty silty sand, which appears massive or fissile. Rare, faint, discontinuous laminations of silt and sand occur in the upper part of the exposed unit between 0.8 and 1.0m depth. "Silt and clay" lenses have been reported to occur within this unit (Dr. P.J. Julig, personal communications, 1998). The author noticed abundant, soft, weathered shale clasts throughout. Matrix grain size consists of 49% sand and 16% clay with a graphic mean grain size of 4.4 phi. The material is extremely poorly sorted, fine-skewed and leptokurtic.

Pebbles and cobbles make up between 1 and 5 percent by volume. Boulders are rare, but present in the exposure. Pebble shapes range from angular to round. 30% of the pebbles are black shale and 23% are angular quartzite fragments; likely from local sources. The remainder originated from the Precambrian Shield some 25 km north of the site.

The massive diamicton is interpreted as subglacial till, a till deposited directly from the base of a glacier. Its grain size distribution and parameters are similar to samples collected off-site from till overlying carbonate bedrock (Figure 6.9). The flexure in the grainsize distribution plot of its matrix, may be the result of this till sample's immaturity, that is, it contains material derived locally that has not been abraded or mixed sufficiently by the glacier. Alternatively, this unit may consist of a series of flowtills, with a minor amount of sorting of the glacial debris by water occurring before and during deposition. Structures associated with flowtills or debris flows were not observed, however, the exposure was small and it limited observation (Figure 6.11).

Stratified silts and very fine sands containing small lens-shaped bodies of a silty diamicton, interpreted as debris flows (possible flowtills), were found resting directly on bedrock (?) in Lee's test pit 8-B (Figure 6.8). Samples of the stratified (8-B-1) and massive (8-B-2) sediments of this unit were very poorly sorted, strongly fine-skewed, and very leptokurtic (Figure 6.10). Folk's Graphic Means of 4.4 phi (8-B-1) and 3.9 phi (8-B-2) were obtained on the samples analyzed. The shapes of the grain size curves suggest that the massive diamicton lenses are probably derived from slumping within the glaciolacustrine sediments and are not flowtills derived directly from glacial debris (Figure 6.9).

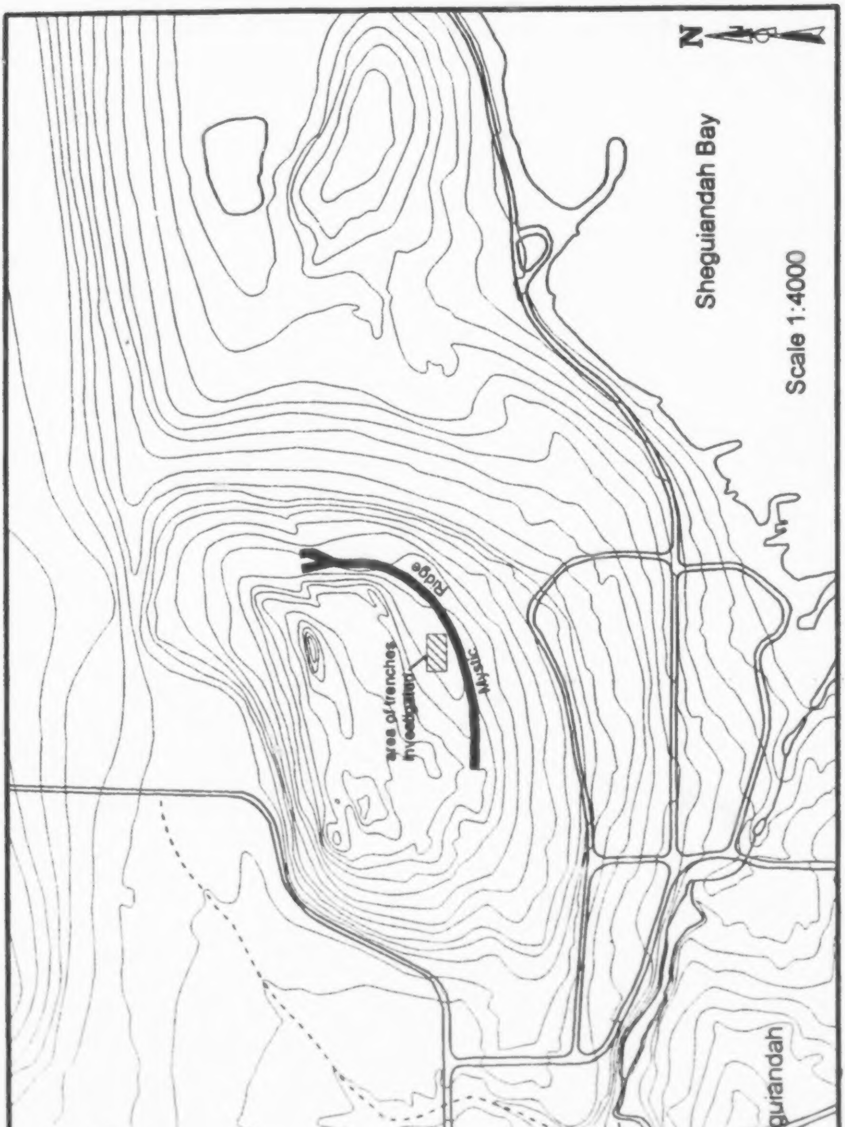

N
Sheguiandah Bay
Scale 1:4000
Mystic Ridge
area of trenches investigation
Sheguiandah

Figure 6.5. Sheguiandah site location map.

Table 6.1: Description and interpretation of materials observed in trenches.

7-8

Interpretation	*Material Description*	*Soil Horizon*
Beach deposits	Massive, organic-rich, silty, pebbly very coarse sand	Ah-disturbed
Beach deposits	Massive, silty, pebbly, coarse sandy granule gravel some cobbles	B
Beach deposits	Massive, very coarse sand and granule gravel, some pebbles, cobbles rare	B
Nearshore deposits	Faintly layered, medium sand to granule gravel, rare clast	B
Wave-washed foreshore	Boulder and cobble gravel with medium sand matrix	C
Till/flowtills	Massive, matrix supported, silty sand with pebbles, cobbles and boulders (~5%) weathered shale and siltstone clasts, rare faint discontinuous laminations near top of unit	C

7-9

Interpretation	*Material Description*	*Soil Horizon*
Beach deposits	Massive, organic-rich, silty, pebbly very coarse sand	Ah-disturbed
Beach deposits	Massive, silty, pebbly, coarse sandy granule gravel some cobbles	B
Beach deposits	Massive, very coarse sand and granule gravel, some pebbles, cobbles rare	B
Nearshore deposits	Faintly layered, medium sand to granule gravel, rare clast	B
Wave-washed foreshore	Boulder and cobble gravel with medium sand matrix	C
Till/flowtills	Massive, matrix supported, silty sand with pebbles, cobbles and boulders weathered shale and siltstone clasts, rare faint discontinuous laminations near top	C

8b

Interpretation	*Material Description*	*Soil Horizon*
Beach deposits	Massive, organic-rich, silty, small pebbly, very coarse sand	Ah-disturbed
Beach deposits	Massive, very silty, pebble to granule gravel with coarse sand	Bt
Beach deposits	Massive, coarse sand and granule gravel, rare pebble	B
Wave-washed foreshore	Pebble gravel in very coarse sand matrix, some cobbles and boulders	Bfe
Debris flow	Massive, silty very fain to fine sand, some small pebbles	C
Near shore deposits	Faintly stratified, fine sand, minor silt	C
Debris flows	Diffusely interbedded, slightly silty, fine sand with granules, and fine sand	C
Near shore deposits	Silty, very fine to fine sand, rare discontinuous clay laminations, rare pebble	C
Boulder or bedrock?	Irregular surface of quartzite, boulder or bedrock?	C

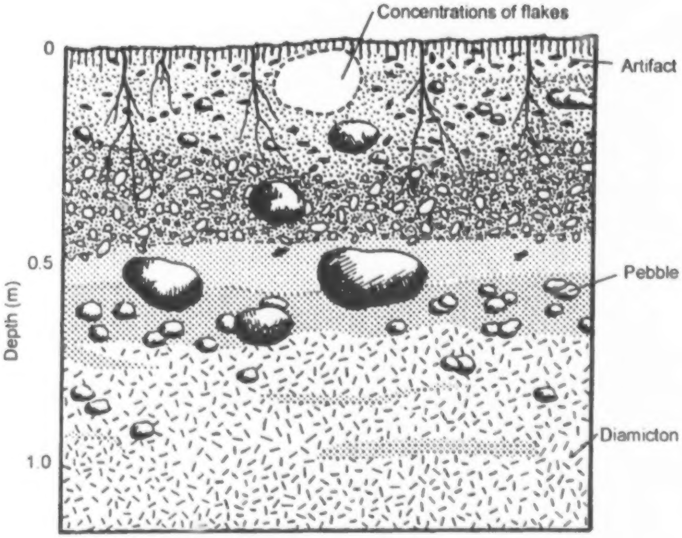

Concentrations of flakes
Artifact
Pebble
Diamicton
0
0.5
1.0
Depth (m)

Figure 6.6. Stratigraphic profile of Station 7-8, west wall, Habitation Area. Sheguiandah Site (BlHl -2). See Table 6.1 for material descriptions. (figure from Julig *et al.* 1994)

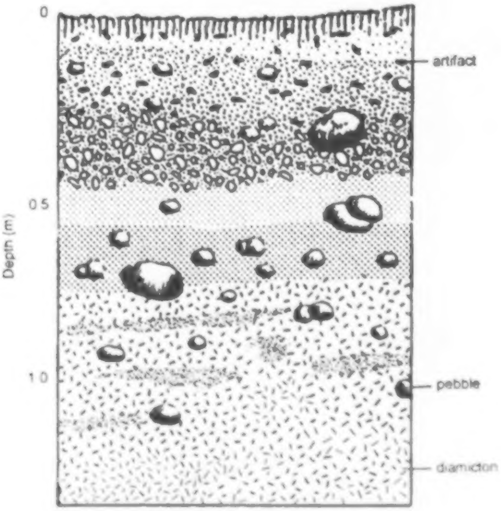

0
0.5
1.0
Depth (m)
artifact
pebble
diamicton

Figure 6.7. Stratigraphic profile of Station 7-9, west wall, Habitation Area, Sheguiandah Site (BlHl-2). See Table 6.1 for material descriptions (figure from Julig *et al.* 1994)

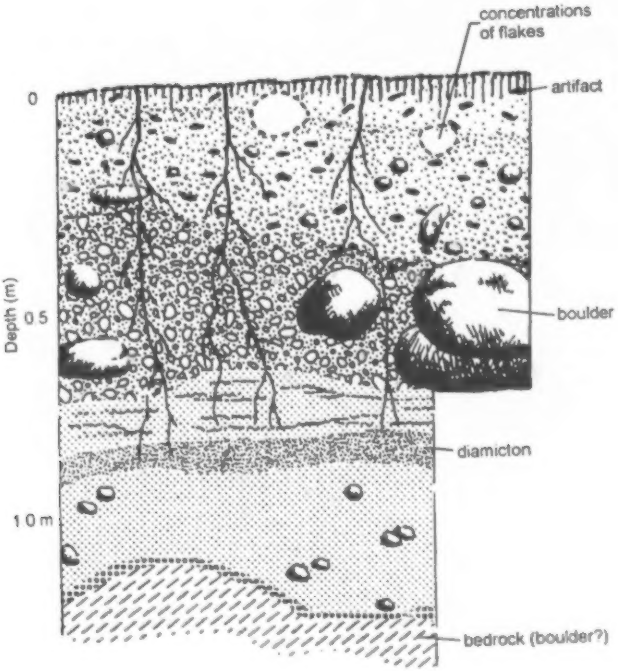


Figure 6.8. Stratigraphic profile of station 8-B, west wall, Habitation Area, Sheguiandah Site (BlHl-2). See Table 6.1 for material descriptions (figure from Julig *et al.* 1994)

Subglacial till was missing in this pit. It may, however, be present at depth below the bottom of test pit 8-B, if the exposed quartzite was a large boulder rather than the bedrock surface. The stratified silts and sands are most likely younger than the till and likely record lake water submergence of the site during deglaciation. Both the subglacial till exposed in test pit 7-8 (SW) (Figure 6.6) and the above unit (debris flows) are overlain by boulder gravel.

Boulder gravel layer

A thin layer of boulder gravel overlies the till in test pit 7-8 (SW) (Figure 6.6). The contact between the till and gravel is sharp, but has local relief of up to 10 cm. The till/gravel contact also coincides with a geochemical boundary (weathering/soil profile boundary) between a highly oxidizing environment in the upper layers of the test pit and a predominantly reducing environment in the till. Root systems are extensively developed in the coarser-grained, oxidized sediments overlying the till.

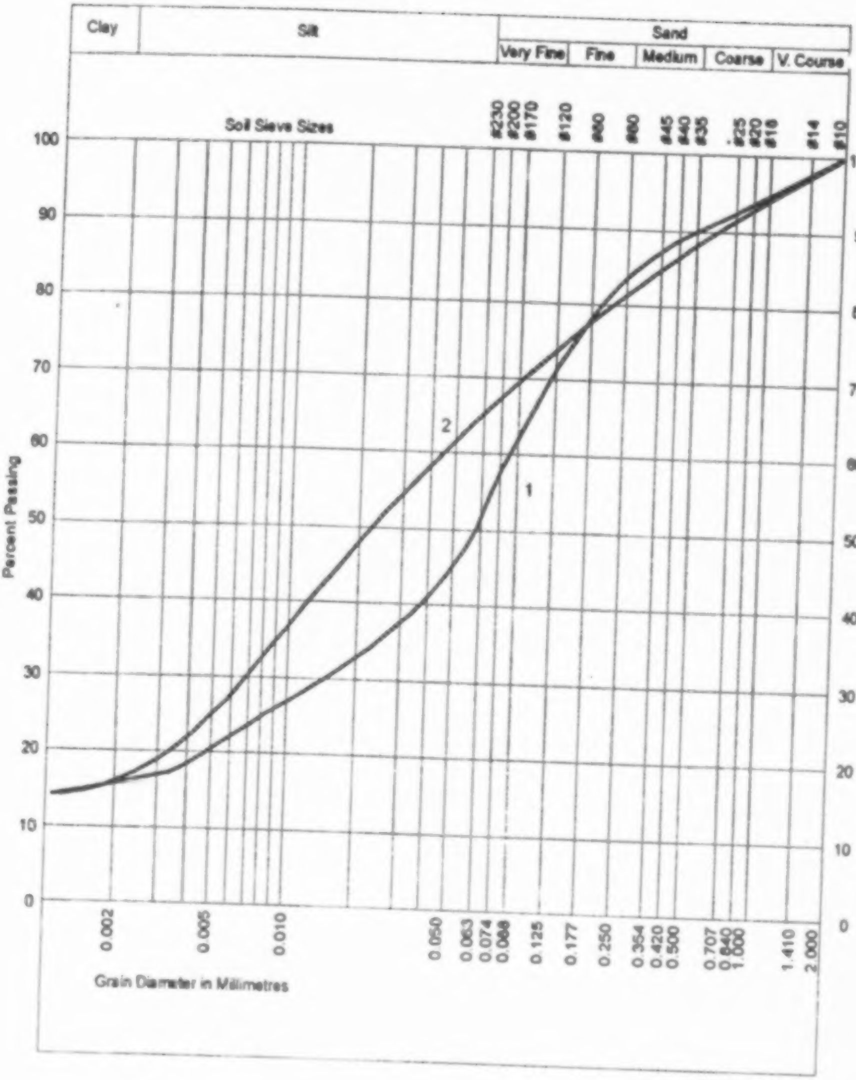


Figure 6.9. Comparison of matrix grain size distribution of on site diamicton interpreted as till (1) and off site sample of till overlying carbonate bedrock (2).

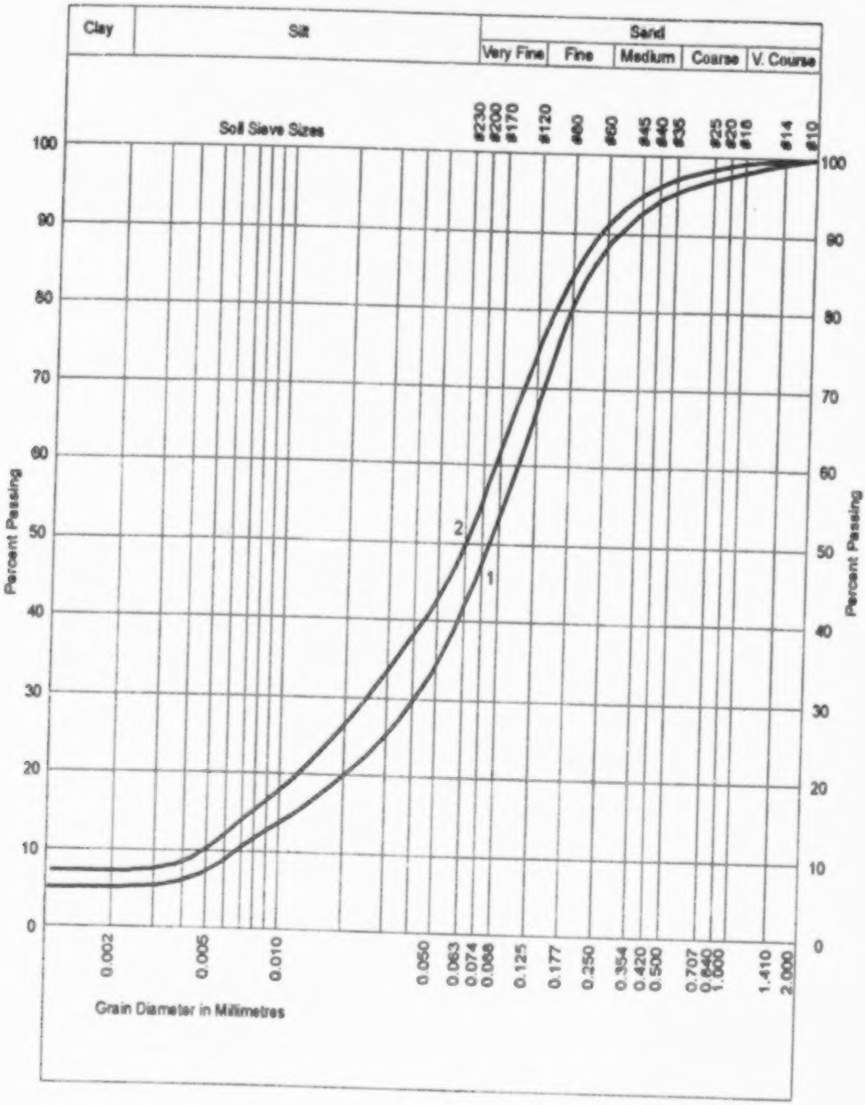


Figure 6.10. Matrix grain size distribution of a sample interpreted as a debris flow (Sample 1 at 90 cm depth) and a sample of surrounding stratified sediment (Sample 2 at 105cm depth), on-site at Station 8-B.

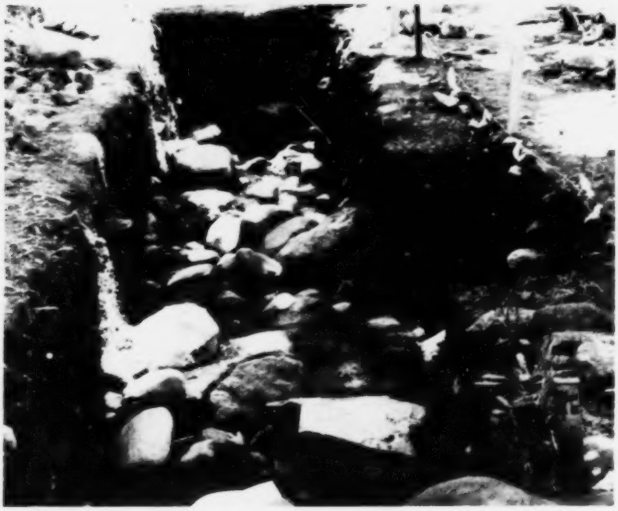


Figure 6.11. Boulder layer at base of trench at Station 7-8 and 7-9 (photo by P.L. Storck).

The gravel layer consists predominantly of boulder-sized rock fragments in a fine to medium-grained sand matrix (Figure 6.11). The boulders, mainly of igneous or metasedimentary rock types, were primarily derived from the Canadian Shield north of Manitoulin Island. However, locally-derived shale, quartzite and calcareous sandstone boulders make up over 30% of the boulders investigated. Approximately 18% of the boulders in the gravel layer were striated on their tops; some having two well-preserved sets. Striation orientation was not consistent between boulders and ranged from 195° to 348 ° N. Boulder shapes range from angular (particularly quartzite boulders) to well rounded (granites/granodiorites and shales). Some boulder surfaces were very irregular due to differential weathering of its component minerals. The overall surface of the boulders is irregular with relief between boulder tops in the order of 15 to 20 cm. The orientation of the boulders was fairly random. However, tabular-shaped boulders generally dip to the northeast. Two boulders appeared to be imbricate with both dipping toward the northeast.

A subglacial origin for the boulder gravel, such as a boulder pavement, is not supported by the above characteristics of the gravel. The irregular upper surface of the boulder layer, combined with the low number of boulders with striated tops and the inconsistency in the direction of these striation, are evidence against such a conclusion. The distally-derived nature of the boulders in the gravel layer compared to the pebbles in the underlying till suggest that this material may have been carried englacially (within a glacier) and deposited during the final stages of deglaciation. They may have been left as a lag of boulders on the surface of the till or flowtill units or they may have been deposited within the upper part of the till or in flowtills and subsequently eroded out from them by subsequent glaciolacustrine or possibly glaciofluvial processes.

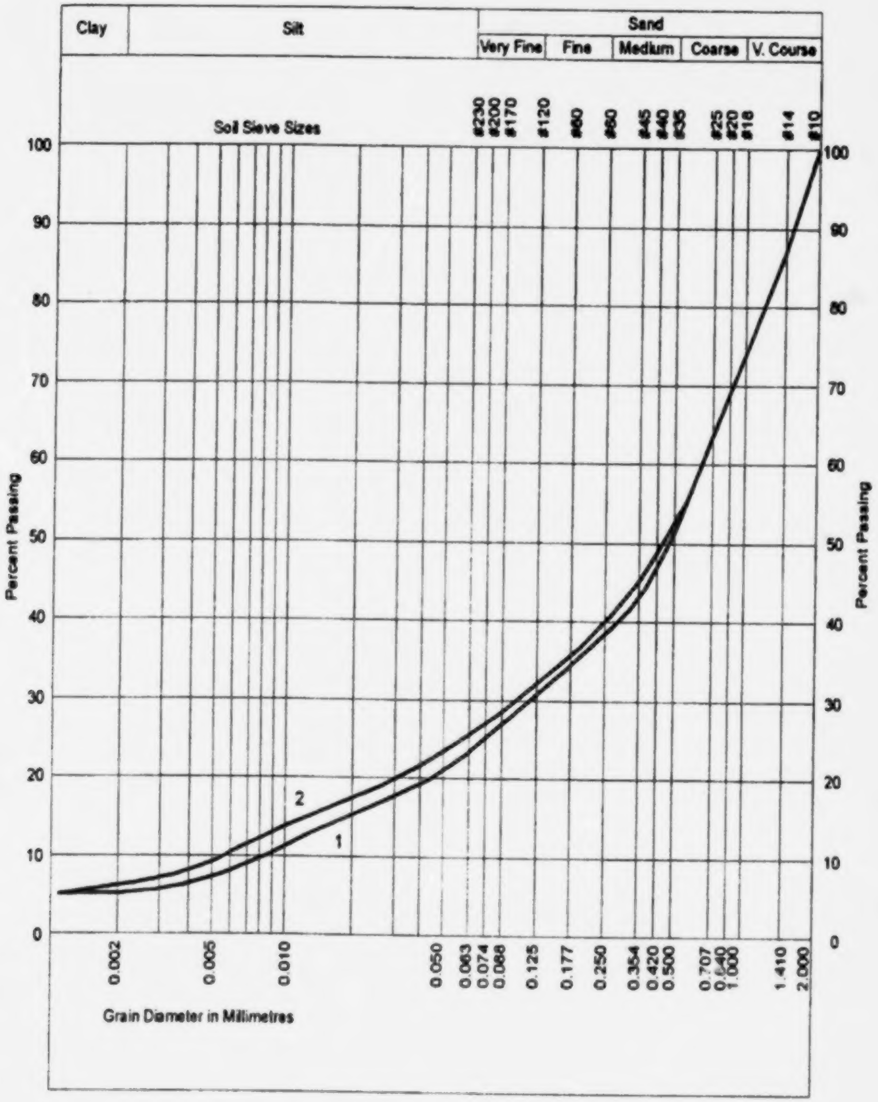


Figure 6.12. Matrix grain size distribution of Lee's two "till" units. Sample 1 taken at a depth of 10 cm and Sample 2 taken at 47 cm depth.

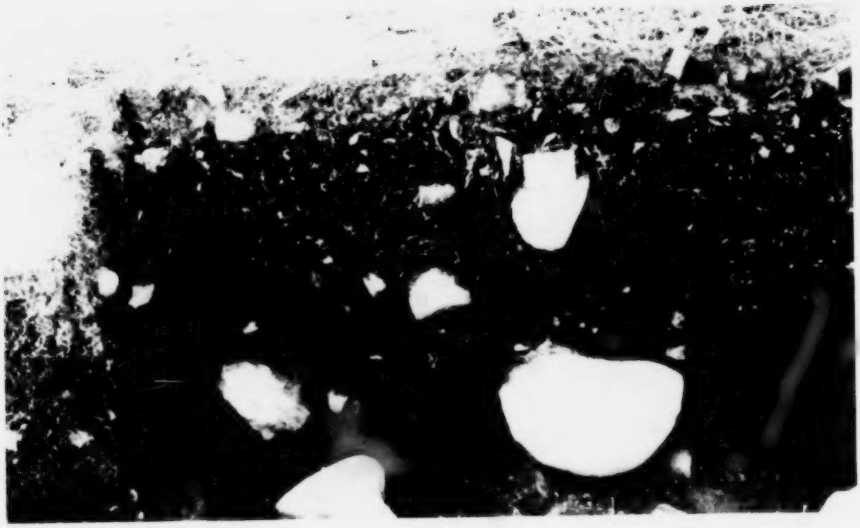


Figure 6.13. Materials exposed on west wall of trench, Station 7-8 (photo by P.L. Storck).

Upper units including "tills" of T.E. Lee

The boulder gravel is overlain by a coarsening-upward sequence of sand and gravel which has been subdivided into 4 units in the past by Thomas Lee (1978) (the upper disturbed zone, till 1, till 2 and a lower sand and gravel layer). The material above the boulder layer, however, is better sorted than the till below or the tills exposed off-site. It is a subrounded to rounded, coarse to very coarse sand and granule gravel. The upper units contain angular to rounded pebbles and cobbles. Samples taken from the 2 "till" units of Lee's had similar grain size distributions (Figure 6.12). They averaged 76% sand and only 17.5% silt and 6.5% clay. Folk's Graphic Mean was -0.67 and -0.23 phi, respectively, being much coarser than the till samples analyzed. They are, however, very poorly sorted, strongly fine-skewed and leptokurtic.

The "dirty feel" and appearance of these upper units, which have led some to suggest that they are tills, may be the result of post-depositional weathering processes (Figure 6.13). The small proportion of fines in these units, enough to give them the "dirty feel", is probably the result of soil-forming processes and the weathering of some of the constituent rock fragments (shale and phyllite fragments) in the sand and gravel. Loess may also have been incorporated in to the upper part of the soil.

Weathered coarse-grained sand and gravel can be observed off-site in the Ferguson Sand and Gravel Pit and in several road cuts in beach deposit west of the site (for example, a beach of probably the Payette phase of glacial Lake Algonquin). Similarities in grainsize distribution between off-site samples of weathered beach sediment (Figure 6.4a) and the upper units at Sheguiandah (Figure 6.12, till 1 and 2 of Lee 1978), lead to the interpretation that the upper units at Sheguiandah are weathered, oxidized nearshore or beach deposits of a post-glacial lake, not till or debris flows.

Korah phase shoreline features of glacial Lake Algonquin occur approximately 14 m above shoreline features of the Nipissing Great Lakes on Manitoulin Island (Cowan 1985). The Nipissing Great Lakes shoreline is at an elevation of approximately 200 m at Sheguiandah. At an elevation of about 214 m, the upper sediments exposed in the trenches at Sheguiandah are most likely nearshore or beach deposits of the Korah phase of glacial Lake Algonquin.

The upper sediments were deposited in a partly sheltered embayment of this lake. The "Mystic Ridge", partly cored by a quartzite boulder conglomerate, is covered by approximately 0.5 m of boulder gravel immediately south of the test pits. Its elevation, above that of the area of the test pits, may have partially protected the test pit area from the full force of waves and currents from the south and southwest. However, the Mystic Ridge decreases in elevation to the east and northeast and becomes lower in elevation than the area of test pits. The mystic ridge may have no longer provided protection to the test site areas: possibly allowing wave and current access from the east and northeast. This may explain the general northeastward dipping orientation of the tabular boulders of the gravel lag. The quartzite ridge, itself, would protect the test pit sites from wave attack from the remaining directions and provide the slope and possible source material for the debris flows identified in some of the lower units (see also von Bitter, this volume).

Conclusions

The sediments exposed in the trenches in the "habitation" area record an environmental change from a subglacial-ice marginal environment to proglacial lake environment to eventual subareal exposure of the site. Overall sediment facies transitions record a lowering of lake levels up until the site was exposed to post-glacial weathering processes.

The sediments referred to and identified as till 1 and 2 by Thomas Lee are probably not tills. They are not debris flows either, as suggested by Hough. These sediments of questionable origin are most likely highly oxidized and weathered nearshore or beach deposits of a postglacial lake, probably the Korah phase of glacial Lake Algonquin.

The general record of sediments preserved at the site suggests that only one subglacial till layer occurs at the site and is located below the artifact-bearing layers. The stratified silty fine and very fine sands containing debris flows are probably younger than the till and likely record local deglaciation of the site. The boulder gravel truncates both these units. It may be a boulder lag produced by the erosion of till and bedrock units exposed within wave base of an ancestral post-glacial lake (Figure 6.14). The overlying sand and gravel layers are beach or nearshore sediments deposited in a partly protected embayment. Their fine component is probably the result of in situ weathering (soil forming processes) and possibly the mixing of a thin surface deposit of loess with the beach sediments by human and natural site disturbance processes.

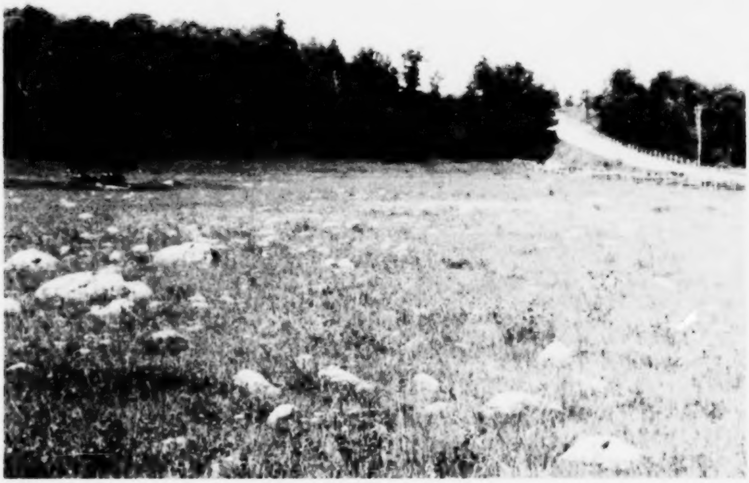


Figure 6.14. Boulder lag formed in the near-shore zone of glacial Lake Algonquin (Payette Phase). The Payette beach ridge can be seen just below the forest edge in this photograph. The boulders have been subjected to post glacial weathering processes.

References

Barnett, P.J. 1989. Tunnel valleys in the Georgian Bay area, Ontario. Montrèal, Quebèc: Geological Association of Canada, *Program with Abstracts*, p. A89.

Barnett, P.J. 1990. Tunnel valleys: evidence of catastrophic release of subglacial meltwater, central-southern Ontario, Canada. Syracuse, New York: Geological Society of America, Northeastern Section, *Abstracts with Programs*, p. 3.

Barnett, P.J., D.R. Sharpe, H.A.J. Russell, T.A. Brennand, G. Gorrell, F.M. Kenny, and A. Pugin. 1998. On the origin of the Oak Ridges Moraine. *Canadian Journal of Earth Sciences,* in press.

Brennand, T., and J. Shaw. 1994. Tunnel channels and associated landforms: their implication for ice sheet hydrology. *Canadian Journal of Earth Sciences* 31: 502-522.

Chapman, L.J. and D.F. Putnam. 1984. *The physiography of southern Ontario*. Ontario Geological Survey, Special Volume 2.

Cowan, W.R 1985. Deglacial Great Lake shorelines at Sault Ste. Marie, Ontario. In *Quaternary Evolution of the Great Lakes*, edited by P.F. Karrow and P.E. Calkin, pp. 33-37. Geological Association of Canada Special Volume No. 30.

Dreimanis, A. 1988. Tills: Their genetic terminology and classification. In *Genetic Classification of Glacigenic Deposits: final report of the Commission on Genesis and Lithology of Glacial Quaternary Deposits of the International Union for Quaternary Research (INQUA)*. Rotterdam, Netherlands: Balkema Publishers.

Eschman, D.F. and P.F. Karrow. 1985. Huron basin glacial lakes: a review. In *Quaternary Evolution of the Great Lakes*, edited by P.F. Karrow and P.E. Calkin, pp. 79-93. Geological Association of Canada, Special Paper 30.

Julig, P.J., P.L Storck and W.C. Mahaney. 1994. Re-Investigations at Sheguiandah: The Application of a Geoarchaeolgical Approach. In *Great Lakes Archaeology and Paleoecology, Exploring Interdisciplinary Initiatives for the Nineties: Symposium Proceeding*, edited by Robert MacDonald. The Quaternary Sciences Institute, University of Waterloo.

Lee, T.E. 1978. Sheguiandah and early man. In *Geology of the Manitoulin Area*, edited by J.T. Sandford and R.E. Mosher. Michigan Geological Society Special Paper 3.

Lewis C.F.M. and T.W. Anderson. 1989. Oscillations of levels and cool phases of the Laurentian Great lakes caused by inflows from glacial Lakes Agassiz and Barlow-Ojibway. *Journal of Paleolimnology* 2: 99-146.

Shaw, J. and G. A. Gorrell, 1991. Subglacially formed dunes with bimodal and graded gravel in the Trenton drumlin field, Ontario, Canada. *Géographie physique et Quaternaire* 45(1): 21-34.

Sly, P.G. and CF.M. Lewis. 1972. *The Great Lakes of Canada-Quaternary geology and limnology*. Montreal: 24th International Congress, Excursion A 43.

Spencer, J.W. 1891. Deformation of the Algonquin beach, and birth of Lake Huron. *American Journal of Science* 41: 12-21.

Chapter 7

Pollen Stratigraphy and Vegetation History, Sheguiandah Archaeological Site

T. W. Anderson

Abstract

Renewed pollen investigations on Swamp 3 sediments at the Sheguiandah archaeological site show five pollen assemblage zones which mirror the original pollen studies at the site. The new, more-detailed pollen stratigraphy, supported by AMS dating, indicates a vegetation succession from an initial open-spruce woodland, to a pine-dominated forest, to a recurrence of spruce (*Picea*) dating 9.4 to 7.8 ka, to a second domination of pine (*Pinus*) accompanied by birch (*Betula*) and hardwoods. The spruce recurrence is common to other sites in the upper Great Lakes region and represents a climatic reversal (cool climate) within a regional warm interval indicated by the widespread domination of pine. The onset of the spruce recurrence correlates with downwind cooling induced by westerly winds blowing across the newly emerged, cold waters of Lake Superior following the retreat of Marquette Ice at 9.5 ka. The replacement of spruce by pine at 7.8 ka is taken to indicate the end of the cool-lake effect when regional warming dominated everywhere throughout the Great Lakes region. The 10.2-9.7 ka period of enhanced warming as documented by the *Pinus* dominance probably was the most favourable window for early Holocene human occupation at Sheguiandah.

Résumé

Les nouvelles études sur le pollen menées dans les sédiments du marais 3 au site archéologique de Sheguiandah montrent cinq zones d'assemblage pollinique qui concordent avec les résultats des études originales effectuées sur ce site. La nouvelle stratigraphie plus détaillée assistée par la datation par SMA indique une succession de végétation qui a commencé avec un boisé d'épinettes ouvert, suivie d'une forêt dominée par le pin, d'une récurrence de l'épinette (*Picea*) remontant de 9,4 à 7,8 millions d'années, d'une deuxième prédominance du pin (*Pinus*) accompagnée de bouleau (*Betula*) et de bois durs. La récurrence de l'épinette est commune dans d'autres sites de la région supérieure des Grands Lacs et représente un revirement climatique (climat frais) dans une période de chaleur régionale indiquée par la vaste prédominance du pin. Le début de la récurrence du pin concorde avec le rafraîchissement, dans le sens du vent, induit par des vents d'ouest soufflant sur les nouvelles eaux froides du lac Supérieur à la suite du recul de la glace Marquette il y a 9,5 milliers d'années. Le remplacement de l'épinette par le pin il y a 7,8 milliers d'années est considéré comme le signe de la fin de l'effet de refroidissement du lac alors que la région des Grands Lacs subissait un réchauffement général. Le réchauffement accru

The Sheguiandah Site: archaeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario, edited by P. Julig. Canadian Museum of Civilization, Archaeological Survey of Canada , Mercury Series Paper 161, 2002.

noté entre 10,2 et 9,7 milliers d'années, dont témoigne la dominance du *Pinus*, a probablement constitué la période holocène la plus favorable à l'occupation humaine de Sheguiandah.

Introduction

Palynological investigations were re-initiated at the Sheguiandah archaeological site on Manitoulin Island, Ontario at the suggestions of P. Julig (Laurentian University) and P. Storck (Royal Ontario Museum). The main purpose of these investigations is to provide supporting evidence to resolve the age of the artifact-bearing deposits previously interpreted by Lee (1957) and Sanford (1957) to date to a warm interval in Wisconsinan time or as early as the Sangamonian interglaciation and to document the paleoenvironmental setting at time of habitation. Consequently, the sediments in Swamp 3, one of several peat depressions at the site (Figure 7.1), were sampled on two occasions. The author visited the site in 1990 and, with assistance from P. Julig, P. Storck and others, obtained a core of the sediments as the swamp was flooded by heavy rainfall at the time. P. Julig and P. Storck re-sampled the swamp site in the summer of 1991 during re-excavation of several of the 1957 trenches and were better able to sample and describe the sediments in their entirety. This report discusses the pollen record of the site based on the suite of samples that Julig and Storck had extracted from the peat and underlying clay. The pollen studies provide information on the local succession of Holocene vegetation and regional climate and the age of human occupation at Sheguiandah.

Pollen studies were initially undertaken on the swamp 3 deposits by Terasmae (Lee 1957) as part of major archaeological and geological investigations of the Sheguiandah habitation area in the 1950s (Lee 1957; Sanford 1957). A more-detailed analysis of the Swamp 3 pollen record is presented here in light of new AMS (^{14}C Accelerator Mass Spectrometry) dates on small quantities of organic materials, and more complete pollen studies. The Sheguiandah pollen record is considered with respect to its significance to the history of lake level change and early Holocene climate (Anderson and Lewis 1992, this volume; Yu and Eicher 1998; Yu 2000) of the northern Lake Huron-Georgian Bay region.

Regional setting, location and description of site

The northern Lake Huron-Georgian Bay basin lies in the western sector of the St. Lawrence Lowlands physiographic region of Bostock (1970); the Sheguiandah site is in the Manitoulin Island physiographic region of Chapman and Putnam (1984). It is bounded to the north by contiguous highlands that reach elevations of over 650 m A.S.L. and to the east, southeast and southwest by disjunctive highlands which rise to over 450 m A.S.L. The climate of the area is influenced greatly by topography and the ameliorating effect of the Great Lakes. The prevailing westerlies blow across the Great Lakes resulting in generally high precipitation in the lee, eastern margins of the lakes; drought prone areas exist in southwest and south-central Ontario where longer dry periods are experienced especially during the summer months than other regions of Ontario (Brown *et al.* 1968)

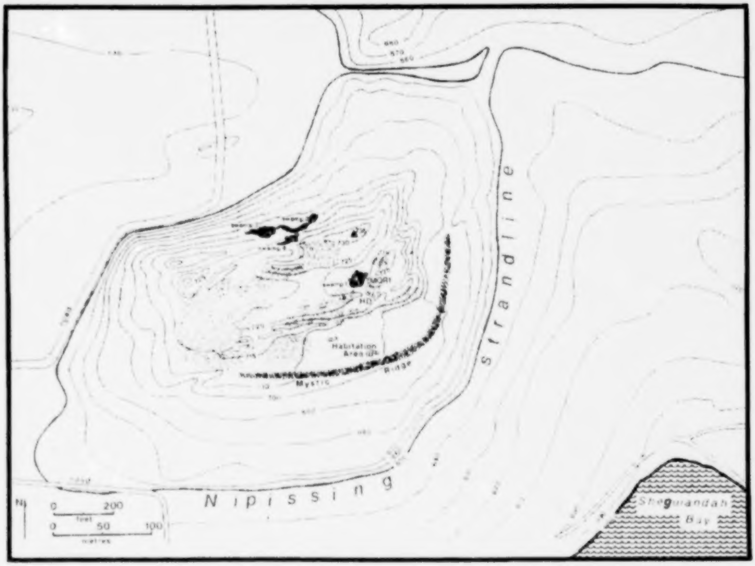


Figure 7.1. Map of the Sheguiandah archaeological site showing location of Swamp 3 (modified after Lee 1957). Elevation contours are shown as feet A.S.L. The 580 foot contour (176.8 m) is the present level of Sheguiandah Bay (Georgian Bay).

The region lies within the mixed forest of the Great Lakes-St. Lawrence Region of Rowe (1972) and the Cool Temperate Ecoclimatic Province (Ecoregions Working Group 1989). Thus coniferous trees common to the Boreal Forest to the north and deciduous trees of the Deciduous Forest to the south comprise the dominant forest cover. Morton and Venn (1984) describe the main types of vegetation based on a detailed classification of the natural vegetation existing on Manitoulin and neighbouring islands. The south-north change in present-day forest cover from south of to north of the Great Lakes is accompanied by a 7°C mean July temperature gradient (Bartlein and Webb 1985).

The 11-7 ka lake-level history of the northern Lake Huron-Georgian Bay region, as it may have affected the Sheguiandah site, is detailed elsewhere (Lewis and Anderson 1989; Lewis *et al.* 1994; 1996; Anderson and Lewis, this volume). Briefly, Main Lake Algonquin occupied Lake Huron and Georgian Bay basins by about 11 ka. Shortly after 10.5 ka, it finally drained northeast via Mattawa, Ottawa and St. Lawrence valleys (Karrow *et al.* 1975; Eschman and Karrow 1985; Barnett 1992), after which, basin water levels descended through a series of high stands (the post-Algonquin lakes) culminating with the early Lake Stanley-Hough low stand at about 10.2 ka. Other high stands (Mattawa phases) and low stands (Mid and Late Stanley phases) dominated from 10.2 ka to as late as 7.5 ka (Lewis *et al.* 1994, 1996; Moore *et al.* 1994; Rea *et al.* 1994).

The latter high stands were supported by inflow from glacial Lake Agassiz; the low stands were marked by restricted, if any, Lake Agassiz inflow. Major inflows to the northern Lake Huron area ceased after 8 ka when glacial lakes Ojibway and Agassiz catastrophically drained into Hudson Bay (Barnett 1992). Later lake phases of the Huron basin included the Nipissing Great Lakes and possibly the Algoma. The well-known Nipissing strandline can be traced completely around Manitoulin Island (Sly and Lewis 1972; Hough 1958; Lewis 1970).

The Sheguiandah archaeological site is located near the northeast corner of Manitoulin Island at the edge of the community of Sheguiandah (Figure 7.1). The site consists of several quarries and a habitation area on the Precambrian quartzite knob which rises to approximately 224 m elevation A.S.L., 47 m above Sheguiandah Bay (Lake Huron). Swamp 3 is located (latitude 45°53.7'; longitude 81°55.4') on the north side of the habitation site at altitude 216 m A.S.L.

Sampling revealed that swamp 3 consists of fibrous peat from the surface to approximately 1.7-1.75 m depth. Mineral sediment consisting of fine sandy clay (1.75-1.9 m) overlies clay with pebbles (1.9-2.2 m) which overlies sandy clay and gravel. The basal sandy clay and gravel are typically till on the basis of grain size (Julig and Mahaney, this volume). The 1991 excavations in Swamp 3 did not confirm the original discovery (Lee 1957) of artifacts associated with the mineral deposits at the base of the swamp. However, quartzite flakes (from lithic reduction by Paleoindians) are present in the sandy clay interface between the base of the peat and the clay with pebbles.

Previous Work

Palynological analyses were previously carried out at the Sheguiandah site by Terasmae (Lee 1957), likewise on Swamp 3. His abbreviated pollen diagram is modified (zoned) and reproduced here as Figure 7.2. The pollen diagram is zoned so that a better comparison can be made with the present study (Figure 7.3) and other pollen records in the area.

Terasmae's diagram is characterized by a *Picea* pollen maximum which dominated the early part of the record. *Picea* reaches upwards to 60% and *Pinus* averages about 30%. The beginning of the *Picea* peak is dated at 9130±250 years BP. Terasmae (Lee 1957) interpreted the *Picea* peak to represent a cold period and correlated it with the Cochrane Ice advance, now thought to be glacial surging (Dyke and Prest 1987; Dredge and Cowan 1989; Barnett 1992). *Picea* was subsequently replaced by maximum percentages of *Pinus*, *Betula*, *Alnus* and minor increases in *Tsuga* and other hardwoods which persisted to the top of the record.

Methodology

Five cores were recovered from the peat with the modified Livingstone piston sampler during the first visit to the site in 1990. These cores were used mainly for radiocarbon dating. Five AMS radiocarbon dates were obtained on the peat and plant remains extracted from organic fractions in the underlying mineral sediment ranging in age from 9.4 to 3.7 ka (Julig and Mahaney, this volume).

The sediments at swamp 3 were excavated and sampled for pollen study in a subsequent excursion to the site in the summer of 1991. At that time Swamp 3 had dried out and the peat was compacted. The depth of sediment was slightly different where it was excavated compared to that in the cores. The peat/clay contact was gradational between about 1.3 to 1.5 m. Two AMS dates were obtained on plant macro-remains from the peat, charred material at 80 cm below surface and conifer needles at 130 cm depth (Table 7.1).

Table 7.1. AMS radiocarbon dates from Swamp 3, Sheguiandah Site, this study.

Sample Depth (cm)	Material Dated	Laboratory Number	Measured ^{14}C Age	$^{13}C/^{12}C$ ratios ($^{0}/_{00}$)	Corrected ^{14}C Age
80	charred material	Beta-92067	7880 ± 50	-26.4	7860 ± 50
130	conifer needles	Beta-92069	9470 ± 60	-28.4	9410 ± 60

Laboratory Notes: Quoted errors represent 1 standard deviation statistics (68% probability) and are based on combined measurements of the sample, background, and modern reference standards. Measured $^{13}C/^{12}C$ ratios were calculated relative to the PDB-1 international standard and the radiocarbon ages BP (years before present) were normalized to -25 per mil.

Prior to chemical treatment for pollen analysis, samples of 1 cc of sediment were determined by water displacement. The treatment procedure basically followed that in Faegri and Iversen (1975). Any coarse sand and silt was initially removed by washing and decanting off the finer fraction which was then subjected to routine analysis. The treatment involved acid digestion of the sediment with hot HF to remove silicates, followed by HCL (to remove carbonates), KOH (to remove humic acids), and finally acetolysis which transforms cellulose constituents into water-soluble products. Residues were washed with alcohol prior to adding silicone oil as the mounting medium.

Counts of about 220-250 fossil tree, shrub and herb pollen were carried out for each sample level. Percentage calculations of the various pollen and spore taxa are based on a sum of tree, shrub and herb pollen excluding aquatic pollen. For ease of discussion, the pollen diagrams are divided into recognizable pollen assemblage zones based on the dominance of one or more taxa. Results of pollen studies of the peat and underlying clay are shown in Figures 7.3a and 7.3b.

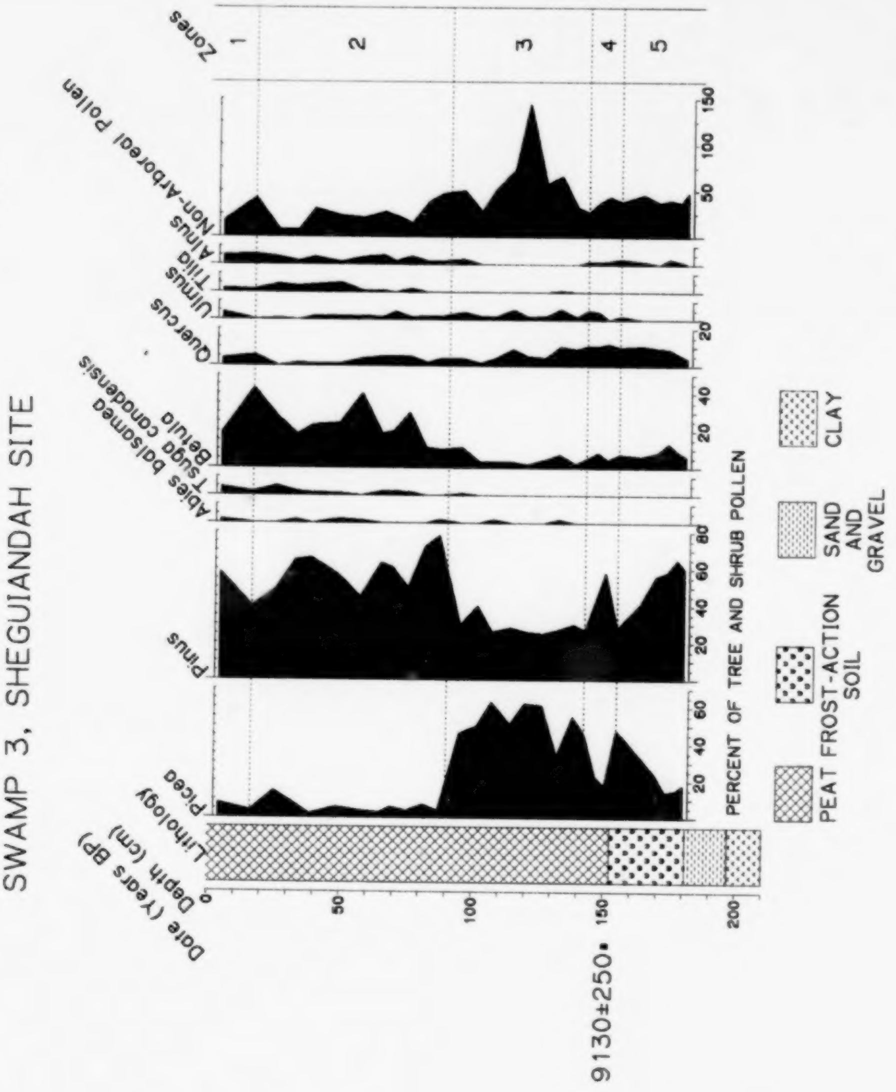


Figure 7.2. Modified pollen diagram of Terasmae, Swamp 3, Sheguiandah site (modified from Lee, 1957).

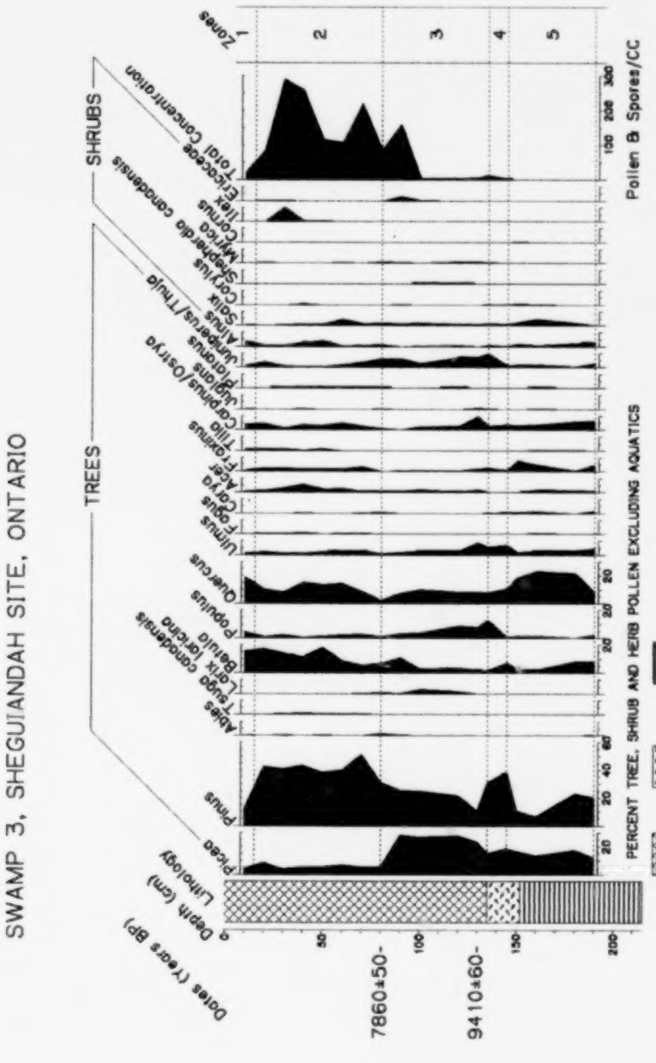


Figure 7.3a. New pollen diagram for Swamp 3, Sheguiandah Site, showing tree and shrub (Figure 7.3a), and herb and aquatic (Figure 7.3b) pollen percentages.

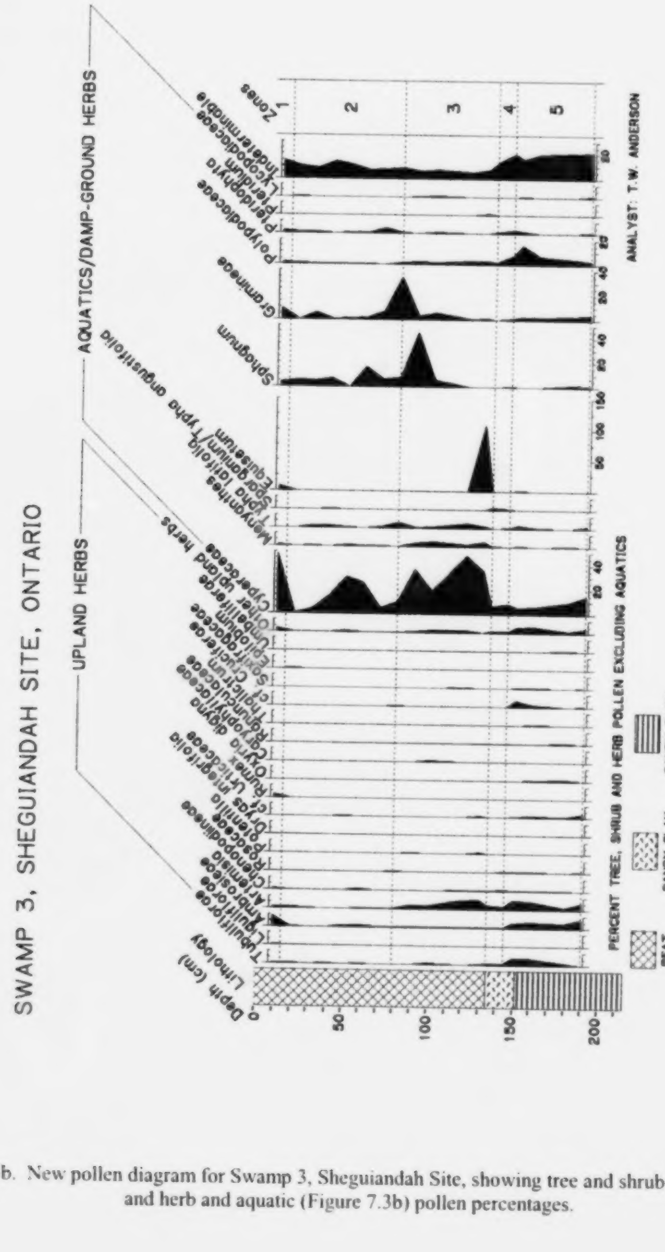


Figure 7.3b. New pollen diagram for Swamp 3, Sheguiandah Site, showing tree and shrub (Figure 7.3a), and herb and aquatic (Figure 7.3b) pollen percentages.

Description of the pollen diagrams

Zone 5

This zone is characterized by an assemblage of *Picea* (spruce), *Salix* (willow) and herb pollen including taxa in the Gramineae (grasses), Compositae (Tubuliflorae), Chenopodiineae (chenopods), Cruciferae (crucifers), Cyperaceae (sedges) and the presence of prominent genera/species such as *Artemisia* (Sagebrush), *Ambrosia* (Ragweed), *Dryas integrifolia* (Smoothleaf Dryas) and *Oxyria digyna* (Mountain Sorrel). *Quercus* (oak) is prominent reaching up to 20% maximum. *Betula* (birch), which resembled tree birch by size measurement, reached less than 10% maximum. Fern spores of Polypodiaceae increase to 15% maximum. The pollen in general was poorly preserved throughout the zone as indicated by up to 20 % indeterminable pollen. This zone is probably equivalent to zone 5 of the modified Terasmae diagram (Figure 7.2).

Zone 4

Significant increases in *Pinus* (pine) results in a *Pinus* peak which characterizes this zone. Herbs, particularly *Artemisia*, which were so prominent in the previous assemblage zone, are absent or decrease to low percentages. *Picea* is unchanged from the previous zone whereas *Quercus* decreases from its earlier maximum; *Populus* (poplar), *Ulmus* (elm) and *Juniperus/Thuja* (Juniper/Cedar) show significant increases from the previous zone. High but decreasing-upward percentages of indeterminable pollen correlate with the same trend in *Pinus*. The high *Pinus* percentages in this zone are the main contributors of the minor peak in pollen and spore concentration; they are correlated with similar high *Pinus* in zone 4 of the Terasmae diagram (Figure 7.2).

Zone 3

This zone is differentiated by a *Picea* maximum. *Pinus* is lower compared to its peak values in the previous zone. Also significant is the return of relatively high values of *Artemisia* comparable to those of zone 5. While other herb/shrub taxa which were prominent in zone 5 but are extremely low or absent in this zone, *Shepherdia canadensis* (soapberry) makes its first and only appearance in this zone but only as a minor constituent. *Populus* and *Juniperus/Thuja* decrease to lower values from the previous zone. The lower *Pinus* percentages of this zone are reflected by extremely low concentrations of pollen and spores. This zone is correlative with zone 3 in the modified diagram of Terasmae.

This zone marks the first appearance of pollen of the aquatics and other damp-ground herbs as successive maxima occur in Cyperaceae, *Equisetum* (horsetail), *Sphagnum* (sphagnum), and Gramineae upwards in the zone. Other aquatics present in small quantities include *Menyanthes* (buckbean) and *Typha latifolia* (cat-tail). Percentages of indeterminable pollen drop significantly from the previous zones. Based on Terasmae's original diagram, Cyperaceae probably represented the largest component of the NAP peak which reached well over 100% in the equivalent zone 3 of the modified diagram of Terasmae.

Zone 2

This zone is characterized by a recurrence of the *Pinus* maximum. *Picea* declines to minimum values whereas *Betula* and *Quercus* increase significantly from the previous zone. *Tsuga canadensis* (hemlock), although minor, appears for the first time and the hardwoods *Ulmus*, *Fagus* (beech), *Acer* (maple), *Fraxinus* (ash) and *Tilia* (basswood) are present as minor occurrences. *Ilex* (holly) reaches peak percentages near the top of the zone. Cyperaceae and *Sphagnum* percents are somewhat sporadic and lower than in the preceding zone. Percentages of indeterminable pollen are higher than in zone 3. The increase in pollen and spore concentration in this and the previous zone reflects the *Pinus* recurrence and its dominance at the expense of spruce. This zone is equivalent to zone 2 in the Terasmae diagram.

Zone 1

This uppermost zone is recognized on the basis of peak but minor percentages of Ambrosieae (ragweed) and *Rumex* (sorrel) and slight increases in Chenopodiaceae and Gramineae. *Pinus* decreases abruptly from maximum to low values across the zone 4/5 boundary whereas *Picea*, *Betula* and the hardwoods remain essentially unchanged from the previous zone. The only other noticeable shift is a sharp increase in Cyperaceae which attains its highest percentages at the top of the profile. The abrupt decline in pollen and spore concentrations mimics the abrupt decline in pine. This zone is equivalent to zone 1 in the modified Terasmae diagram. The uppermost sample in Figure 7.2 is closer to the surface than that in Figure 7.3; the surface NAP increase, therefore, most likely reflects higher percentages of modern grass, *Ambrosia* and other weed pollen.

Paleoenvironmental Interpretation

Depositional History

Initially at least, the depositional changes at the site are tied to the sequence of water-level changes in the Lake Huron-Georgian Bay basins (Lewis and Anderson, 1989; Lewis *et al.*1994; 1996; Anderson and Lewis, 2002). The site emerged from under Lake Algonquin and the post-Algonquin lake phases between about 10.5 and 10 ka. Bluffs attributed to the Korah level, the lowest of the post-Algonquin lakes, occur at approximately 210-215 m in the area west of Sheguiandah (Sly and Lewis, 1972; Hough, 1958), similar elevation as the swamp-bottom dates at Sheguiandah (214.5-214.9 m). Thus the Korah level was probably the last of the declining Algonquin-post-Algonquin lake phases to have inundated the site. The sandy clay layer may represent the Early Mattawa high stand which apparently rose high enough to have washed over and reworked the site (Anderson and Lewis, this volume). Dates of 9130 BP (Lee, 1957), 9170 BP, 9230 BP and 9440 BP (Julig and Mahaney, this volume) on wood and peat in the sandy clay at the base of Sheguiandah swamp provide a minimum age for retreat of the Early Mattawa high stand.

The change from sandy clay to peat reflects the cessation of the effect of Lake Huron-Georgian Bay water levels and the transformation of the site to an enclosed small basin with peat deposition. The preponderance of sedge (Cyperaceae) and *Equisetum* and initial appearances of other aquatic indicators such as *Menyanthes*, *Typha*, *Sparganium*, and *Potamogeton* suggest the site resembled a sedge fen at 9.4 ka. The fen gradually filled in and the site transformed to a bog at 90 cm depth indicated by the peak in *Sphagnum* and increase in grass (Gramineae) at approximately 8.2 ka. Seeds of *Juncus* are prevalent at the top of the diagram suggesting that this taxon is probably the largest contributor to the uppermost peak of Cyperaceae pollen.

Forest Succession and Climate History

The predominance of spruce and herb pollen in zone 5 indicates open-woodland vegetation, not unlike that at the forest-tundra transition of northern Canada, existed in and around the site at this early stage. Similar percentages of contemporary spruce and herb pollen prevail across the forest-tundra boundary in north-west Quebec as illustrated at sites 9-16 in Gajewski (1991). The unusually high representation of oak and moderate amounts of pine are attributed to long-distance dispersal across open tundra or forest-tundra landscapes from oak/pine-dominated forests located well to the south of the site.

Significant increases in pine in zone 4 represent climatic amelioration and onset of the regional pine period that characterizes most pollen records in the Great Lakes region (Wright, 1964). The majority of the pine pollen in this zone is considered to be *Pinus banksiana* (jack pine) but positive identification was not possible due to poor pollen preservation. The high frequencies of indeterminable pollen in this zone may be attributed to reworking of the site by the Early Mattawa high stand (Anderson and Lewis, this volume). Pine forest was widespread and improved climatic conditions are implied. Slight increases in *Populus* and *Juniperus*/*Thuja* suggest that poplar and most likely cedar rather than juniper may have been present locally.

The replacement of pine by spruce at 9410 BP represents a pollen anomaly, i.e., climatic reversal, as the pine increase of zone 4 was interrupted by the return of spruce. This same pollen anomaly is also recognized at nearby Greenbush Swamp, located approximately 7 km northeast of the site (Warner, *et al.*1984). At Greenbush Swamp, the pollen anomaly commences at 9930 BP within a period dominated by high pine (in this case *Pinus banksiana/resinosa* type) and continues uninterrupted to about 8000 BP. Other sites in the area, i.e., Kincardine in eastern Lake Huron area (Karrow, *et al.*1975), show the anomaly as a lingering persistence of spruce dating to 7.6 ka. Here, spruce persisted well into the period of *Pinus* dominance implying a lingering cold period which lasted into the mid-Holocene. Other anomalies of similar type exist throughout the upper Great Lakes region and are documented in more detail in Anderson and Lewis (this volume).

Pine replaced spruce as the dominant forest component at 7860 BP at Sheguiandah and at approximately 8000 BP at Greenbush (based on rates of sedimentation). According to Warner *et* *al.* (1984), *Pinus strobus* (white pine) was the dominant pine in the area at this time. Thus climatic conditions ameliorated for a second time (zone 2 time) which also allowed birch and hardwoods such as oak, maple, beech, ash and basswood to migrate into the area. Judging by the small representation of hemlock pollen, hemlock may have been near its northern distributional limit in this area at this time.

The minor increases in grass and weed pollen (mostly *Ambrosia* and *Rumex*, other taxa within the Compositae, and Chenopodiaceae) of zone 1 reflect early colonial activities associated with forest clearing and settlement in the mid to late 1800's. The decrease in pine percentages likely represents a real decrease of white pine trees from widespread logging and clearing for farming.

Discussion

The new pollen stratigraphy for the Sheguiandah site mirrors that in the original study by Terasmae. Furthermore, both Sheguiandah pollen diagrams closely resemble the Greenbush Swamp record (Warner *et al.* 1984) in showing an upward succession commencing with spruce and herbs followed by the bimodal dominance of pine and intervening spruce recurrence.

The glacial-early Holocene transition of the Great Lakes region is documented by three climatic oscillations between about 11.5 and 9.5 ka (Yu and Eicher 1998; Yu 2000). Two of these oscillations affected the Sheguiandah site, the Younger Dryas (YD) cool interval at 11-10 ka and the Preboreal Oscillation (PB) at 9.6 ka. The YD climatic oscillation coincided in part with Main Lake Algonquin and is represented in part by the cold pollen assemblage zone 5. The increase in *Pinus* in zone 4 indicates climatic warming following the YD cool interval. The PB oscillation is dated at 9.7-9.4 ka at Plate and Strain Lakes in eastern Georgian Bay (Anderson and Lewis, this volume). It is not apparent at the Sheguiandah site as the timing of the oscillation coincides with flooding and reworking of the site by the Early Mattawa highstand.

The most likely late-Quaternary window for Paleoindians to have occupied Sheguiandah would have been after the site emerged from under Main Lake Algonquin and the post-Algonquin lakes and lake levels fell to the Early Stanley lowstand, i.e., between 10.2 to 9.7 ka. The sudden increase in *Pinus* (to 40% at Sheguiandah and close to 50% at Greenbush) indicates the climate was warming dramatically by this time making it more favourable to human occupation. Several hundred years later, or by 9.4 ka, however, the climate cooled abruptly as evidenced by the equally abrupt replacement of pine by spruce (pollen zones 3 at Sheguiandah and Greenbush). The spruce recurrence represents a climatic reversal as it occurred within the *Pinus*-dominated period when pine populations advanced northward into the Great Lakes region in response to regional climatic warming (Wright 1976). The presence of the spruce recurrence at other locations in and around the upper Great Lakes (Anderson and Lewis 1992, this volume) suggests that the pollen anomaly and interpreted climatic reversal is not site specific but is regional in extent. AMS dating at Sheguiandah places the cool climate event between 9.4 and 7.8 ka. The AMS date of 9410 BP at Sheguiandah further suggests that the gyttja date of 9930 BP for the same pollen horizon (*Picea* rise) at Greenbush (Warner *et al.* 1984) may be too old by

500 or more years possibly because of hard water error or the admixture of recycled organic matter.

The persistence of spruce and lingering cold conditions well into the mid-Holocene in the northern Lake Huron area (to 7.8 ka at Sheguiandah and to 7.6 ka at Kincardine) may be accounted for by changes in air mass circulation to the west of the area when the Laurentide Ice retreated out of Lake Superior basin about 9500 BP (Anderson and Lewis, this volume). With retreat of the Laurentide Ice (Marquette Advance), Pacific air, blowing across the newly emerged, cold waters of Lake Superior, would have cooled terrestrial areas as far eastward as Manitoulin Island and the Sheguiandah site. The Lake Superior effect terminated when the regional climate of the upper Great Lakes improved shown by the decline in spruce and second increase in pine dated 7.8 ka at Sheguiandah. The onset of regional warming correlates with estimates of final glacial lake drainage in the northern Great Lakes area (Barnett 1992).

The cool, wet climate that gave rise to the spruce recurrence also provided optimum conditions for onset of peat growth at Sheguiandah. Correlated with the spruce recurrence was a succession from sedge fen to *Sphagnum* and grass-rich bog. Rates of sedimentation amounted to about 0.3 mm/yr during the spruce recurrence but decreased 3-fold after 7.8 ka in response to climatic improvement. A similar response is also recorded at Greenbush Swamp (Warner *et al.* 1984) at about the same time that the spruce recurrence gave way to pine. The Greenbush site had evolved from a shallow alkaline lake prior to 8 ka to a minerotrophic fen marked by abrupt increases in plant macro and faunal species common to floating fens by about 7 ka.

Conclusions

1. Northeastern Manitoulin Island and the Sheguiandah site would have emerged from under Main Lake Algonquin and the post-Algonquin glacial lakes when these high-level lakes drained to the St. Lawrence via Mattawa and Ottawa valleys and Lake Huron-Georgian Bay basin lake levels fell to the Early Stanley lowstand between about 10.2 and 9.7 ka.

2. Once emerged, the initial vegetation in the vicinity of the site resembled open woodland comprising mainly spruce and upland herbs.

3. Perhaps the most favourable time for initial early human occupation at Sheguiandah was between 10.2 and 9.7 ka when the climate had improved dramatically indicated by the replacement of woodland by pine.

4. Locally, by about 9.4 ka, however, the *Pinus* advancement was aborted and spruce became dominant again. This same pollen anomaly is also recognized at nearby Greenbush Swamp, located approximately 7 km northeast of the site and at other sites in and around northern Lake Huron and Lake Superior.

5. The replacement of spruce by pine at 7.8 ka signalled the onset of regional warming, i.e., the mid-Holocene altithermal, throughout the upper Great Lakes.

Acknowledgements

P. Storck and P. Julig assisted with lake sediment coring in 1990 and kindly retrieved samples for pollen analysis during excavations in Swamp 3 in 1991. AMS radiocarbon dating of the plant remains from the swamp was funded under projects at Atlantic GSC, Bedford Institute of Oceanography, Dartmouth. I benefited greatly from discussions with C.F.M. Lewis who reviewed an earlier version of the manuscript. P. Julig provided grain size data on the mineral sediments at the base of Swamp 3 and helpful comments on the manuscript.

References

Anderson, T.W. and C.F.M. Lewis. 1992. Climatic influences of deglacial drainage changes in southern Canada at 10 to 8 ka suggested by pollen evidence. *Géographie physique et Quaternaire* 46: 255-272.

Barnett, P.J. 1992. Quaternary geology of Ontario. In *Geology of Ontario*, edited by P.C. Thurston, H.R. Williams, R.H. Sutcliffe and G.M. Scott, pp. 1011-1088. Ontario Geological Survey, Special Volume 4, Part 2.

Bartlein, P.J. and T. Webb III. 1985. Mean July temperature at 6000 yr B.P. in eastern North America: Regression equations for estimates from fossil-pollen data. *Syllogeus* 55: 301-342.

Bostock, H.S. 1970. Physiographic subdivisions of Canada. In *Geology and Economic Minerals of Canada*, edited by R.J.W. Douglas, pp. 10-30. Geological Survey of Canada, Economic Geology Report No. 1.

Brown, D.M., G.A. McKay and L.J. Chapman. 1968. The climate of southern Ontario. Department of Transport, *Climatological Studies*, No. 5.

Chapman, L.J. and D.F. Putnam. 1984. *The Physiography of Southern Ontario*. Toronto: Ontario Ministry of Natural Resources, Ontario Geological Survey, Special Volume 2, 270 p.

Dredge, L.A. and W.R. Cowan. 1989. Quaternary geology of the southwestern Canadian Shield. In, *Quaternary Geology of Canada and Greenland*, edited by R.J. Fulton, pp. 214-235. Geological Survey of Canada, no. 1.

Dyke A.S. and V.K. Prest. 1987. Late Wisconsinan and Holocene history of the Laurentide Ice Sheet. *Géographie physique et Quaternaire* 41: 237-263.

Ecoregions Working Group, 1989. *Ecoclimatic regions of Canada, First approximation*. Environment Canada: Ecoregions Working Group of the Canada Committee on Ecological Land Classification. Ecological Land Classification Series, No. 23.

Eschman, D.F. and P.F. Karrow. 1985. Huron basin glacial lakes: a review. In *Quaternary Evolution of the Great Lakes*, edited by P.F. Karrow and P.E. Calkin, pp. 79-93. Geological Association of Canada, Special Paper 30.

Faegri, K. and J. Iversen. 1975. *Textbook of pollen analysis*. Copenhagen: Munksgaard.

Gajewski, K. 1991. Représentation pollinique actuelle à la limite des arbres au Nouveau-Québec. *Canadian Journal of Earth Sciences* 28: 643-648.

Hough, J.L. 1958. *Geology of the Great Lakes*. Urbana, Illinois: University of Illinois Press.

Karrow, P.F., T.W. Anderson, A.H. Clarke, L.D. Delorme and M.R. Sreenivasa. 1975. Stratigraphy, paleontology and age of Lake Algonquin sediments in southwestern Ontario, Canada. *Quaternary Research* 5: 49-87.

Lee, T.E. 1957. The antiquity of the Sheguiandah Site. *The Canadian Field-Naturalist* 71: 117-147.

Lewis, C.F.M. 1970. Recent uplift of Manitoulin Island, Ontario. *Canadian Journal of Earth Sciences* 7: 665-675.

Lewis, C.F.M. and T.W. Anderson. 1989. Oscillations of levels and cool phases of the Laurentian Great Lakes caused by inflows from glacial Lakes Agassiz and Barlow-Ojibway. *Journal of Paleolimnology* 2: 99-146.

Lewis, C.F.M., T.C. Moore, Jr., D.K. Rea, T.W. Anderson and L.C.K. Shane. 1996. Sediments of the Huron basin: glacial and periglacial limnology. Geological Association of Canada, *Program with Abstracts* 21: A-56.

Lewis, C.F.M., T.C. Moore, Jr., D.K. Rea, D.L. Dettman, A.M. Smith and L.A. Mayer. 1994. Lakes of the Huron basin: their record of runoff from the Laurentide Ice Sheet. *Quaternary Science Reviews* 13: 891-922.

Moore, T.C., Jr., D.K. Rea, L.A. Mayer, C.F.M. Lewis and D.M. Dobson. 1994. Seismic stratigraphy of Lake Huron-Georgian Bay and post-glacial lake level history. *Canadian Journal of Earth Sciences* 31: 1606-1617.

Morton, J.K. and J.M. Venn. 1984. *The flora of Manitoulin Island and the adjacent islands of Lake Huron, Georgian Bay and the North Channel*. Department of Biology, University of Waterloo, Waterloo, Ontario.

Rea, D.K., T.C. Moore, T.W. Anderson, C.F.M. Lewis, D.M. Dobson, D.L. Dettman, A.J. Smith and L.A. Mayer. 1994. Great Lakes paleohydrology: complex interplay of glacial meltwater, lake levels, and sill depths. *Geology* 22: 1059-1062.

Rowe, J.S. 1972. *Forest regions of Canada*. Department of Fisheries and the Environment, Canadian Forestry Service, Publication No. 1300.

Sanford, J.T. 1957. Geologic observations at the Sheguiandah site. *The Canadian Field-Naturalist* 71: 138-148.

Sly, P.G. and C.F.M. Lewis. 1972. *The Great Lakes of Canada-Quaternary geology and limnology*. Montreal: 24th International Geological Congress.

Warner, B.G., R.J. Hebda and B.J. Hann. 1984. Postglacial paleoecological history of a cedar swamp, Manitoulin Island, Ontario, Canada. *Palaeogeography, Palaeoclimatology, Palaeoecology* 45: 301-345.

Wright, H.E., Jr. 1964. Aspects of the early postglacial forest succession in the Great Lakes region. *Ecology* 45: 439-448.

Wright, H.E., Jr. 1976. The dynamic nature of Holocene vegetation. *Quaternary Research* 6: 581-596.

Yu, Z. 2000. Ecosystem response to Lateglacial and early Holocene climate oscillations in the Great Lakes region of North America. *Quaternary Science Reviews* 19: 1723-1747.

Yu, Z.C. and U. Eicher. 1998. Abrupt climate oscillations during the last deglaciation in central North America. *Science* 282: 2235-2238.

Chapter 8

Upper Great Lakes Climate and Water-Level Changes 11 to 7 ka: Effect on the Sheguiandah Archaeological Site

T.W. Anderson and C.F.M. Lewis

Abstract

The Sheguiandah site lies on the upper slopes of a quartzite knob with a summit elevation of 224 m A.S.L. on eastern Manitoulin Island; the summit is 47 m above present Georgian Bay lake level, 85 m below the paleo-Lake Algonquin level, and 26 m above the former level of the Nipissing Great Lakes. The site proximity to former lakes and its climate history are reinterpreted in light of new cores, AMS radiocarbon dates and pollen stratigraphy in conjunction with regional migration of the spruce-pine ecotone and reconstructed water-level history. Re-sampling of bog sediments reveals an upward pebbly clay-sandy clay-peat succession. The basal clay possibly equates with submergence by high Lake Algonquin and subsequent falling lake phases dating 11.3 to 10.2 ka. The sandy clay probably represents wave erosion of a later large lake, the Early Mattawa highstand beginning about 9.5 ka, as peat accumulation which began after 9.5 ka correlates with a subsequent lake-level fall to the Middle Stanley lowstand. Late glacial and early Holocene climate oscillations in the Great Lakes region, correlated to the classic North Atlantic Younger Dryas (11 - 10 ka) and Pre-boreal Oscillation (PB) (9.7 ka), affected the Manitoulin region; the PB is documented by a *Picea* (spruce) pollen recurrence in eastern Georgian Bay from 9.7 to 9.4 ka. Prolonged cooling until 7.8 ka on Manitoulin Island, marked by continued presence of the spruce pollen recurrence at Sheguiandah and Greenbush Swamp, is attributed to downwind effects from the newly deglaciated Lake Superior water surface to the west. This lake effect potentially intensified after 9.5 ka as westerly airflow replaced circulation dominated by the retreating Laurentide Ice Sheet. The optimum window for site occupation was likely 10.2 to 9.7 ka, between highstands, when the Manitoulin climate was warming and *Pinus* dominated the northward retreating spruce-pine ecotone. Although cooler, a second optimum window for occupation was 9 to 8.5 ka when lake levels were high and the lakeshore was relatively close to the site.

Résumé

Le site de Sheguiandah se trouve sur les versants supérieures d'un pinacle de quartzite culminant à 224 m d'altitude du coté oriental de l'Île Manitoulin; le sommet est à 47 m au-dessus du niveau actuel de la baie Georgienne, à 85 m au-dessous du niveau du paléolac Algonquin et à 26 m au-dessus de l'ancien niveau des Grands lacs Nipissing. La proximité d'anciens lacs et l'histoire du climat du site sont interprétés de nouveau à la lumière de nouvelles carottes, de la datation au carbone 14 par SMA et de la stratigraphie pollinique, en conjonction avec la migration régionale de l'écotone épinette-pin et de l'histoire reconstituée du niveau d'eau. Les nouveaux échantillons pris dans les sédiments de tourbières hautes révèlent une succession

The Sheguiandah Site: archaeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario, edited by P. Julig. Canadian Museum of Civilization, Archaeological Survey of Canada, Mercury Series Paper 161, 2002.

montante d'argile granuleuse, d'argile sablonneuse et de tourbe. L'argile de base correspond probablement à la phase de submergence du lac Algonquin supérieur et des phases subséquentes d'abaissement datant de 11,3 à 10,2 milliers d'années. L'argile sablonneuse concorde probablement avec l'abrasion marine d'un grand lac ultérieur, le Mattawa ancien de haut niveau, qui a commencé il y a environ 9,5 milliers d'années. L'accumulation de tourbe qui a débuté il y a moins de 9,5 milliers d'années correspondrait pour sa part à un abaissement subséquent du niveau du lac jusqu'au niveau inférieur du Stanley moyen. Les variations de la fin de la période glaciaire et du début de la période Holocène dans la région des Grands Lacs, qui correspondent au Dryas récent de l'Atlantique Nord (11 - 10 milliers d'années) et à la variation préboréale (9,7 milliers d'années), ont touché la région de Manitoulin; la variation préboréale est prouvée par une récurrence du pollen d'épinette (*Picea*) dans l'est de la baie Georgienne de 9,7 à 9,4 milliers d'années. Le refroidissement prolongé jusqu'à il y a 7,8 milliers d'années sur l'Île Manitoulin, marqué par la présence continue de la récurrence du pollen d'épinette à Sheguiandah et dans le marais Greenbush, est attribué aux effets éoliens sur l'ouest de la surface du lac Supérieur récemment dégelée. Cet effet produit par le lac s'est probablement intensifié il y a un peu moins de 9,5 milliers d'années, car le courant d'air venant de l'ouest a remplacé la circulation d'air dominée par le retrait de l'inlandsis laurentidien. La période optimale d'occupation du site s'est probablement située entre 10,2 et 9,7 milliers d'années, entre des périodes d'élévation du niveau de l'eau, lorsque le climat de Manitoulin se réchauffait et que le pin dominait dans l'écotone épinette-pin qui se retirait vers le nord. Quoique plus fraîche, une deuxième période optimale d'occupation s'est située entre 9 et 8,5 milliers d'années lorsque le niveau du lac était haut et que le rivage se trouvait relativement près du site.

Introduction

Concepts of the 11 to 7 ka sequence of water level changes in the upper Great Lakes basins have evolved since uplifted geomorphic coastal features of the Lake Algonquin shore were first recognized in the Georgian Bay basin by Spencer (1891), and subsequent shoreline and glacial geological studies were synthesized by Leverett and Taylor (1915). Following this synthesis, and the analysis of uplifted shoreline tilts by Stanley (1936), Hough (1955; 1958; 1962) recognized lowstand unconformities in offshore sediment sequences. He proposed a new model of lake-level change in which a proglacial highstand led to extremely low levels upon drainage of the glacial lakes, followed by gradually rising levels to the Nipissing Great Lakes phase about 5 ka due to differential glacio-isostatic rebound. Eschman and Karrow (1985) show essentially the same model of lake-level change with improved chronology. Subsequently, Huron basin lake- level changes in the 11- 7 ka periods were found to be influenced by episodes of eastward drainage of glacial Lake Agassiz (Lewis and Anderson 1989). Evidence of numerous lowstands was also found in offshore sediments (Moore *et al.* 1994; Rea *et al.* 1994), and both onshore and offshore records were combined in a new synthesis of Huron basin water levels (Lewis *et al.* 1994). Following a new quantification of glacio-isostatic rebound, elevations of new and previously-known lake-level indicators are reconstructed in this paper to reveal more detail and new insights into the complex sequence of high lake levels and lowstands in the Huron-Georgian Bay basins.

The late-Quaternary pollen succession of the Great Lakes region is well documented from terrestrial records inland from the lakes (Yu and Eicher 1998; Yu 2000; Liu 1990; Bennett 1987; Mott and Farley-Gill 1978) and bordering the lakes (Shane 1987; Shane and Anderson 1993;

McAndrews 1981; Karrow *et al.* 1975), supplemented by others from the lakes (Lewis and Anderson 1989; McAtee 1977; Zilans 1985). Records from the lower Great Lakes region (Erie-Michigan lowlands) show a typical succession from herbs to spruce to pine and hardwoods. However, within this region, the pine-dominated period is interrupted by an anomalous spruce recurrence which is correlated with the North Atlantic Younger Dryas climatic event (Shane 1987; Shane 1989; Shane and Anderson 1993). Records from the central Great Lakes region (southern Ontario) show the pine-dominated period is interrupted by another spruce recurrence which is attributed to the North Atlantic Pre-boreal Oscillation (Yu and Eicher 1998; Yu 2000; Yu and Wright 2001). Still further north in the upper Great Lakes region, pollen records display a persistence of spruce (prolonged cooling) late into the pine-dominated (warm) interval (Lewis and Anderson 1992). The pollen anomalies represent a change in the direction of progressive vegetation development and climatic stability, a climatic reversal or revertance according to the criteria favouring unidirectional change (Cushing 1967).

The history of the Sheguiandah site is closely tied to the water-level history of the upper Great Lakes and the record of climate change within and bordering the Great Lakes. Here, we review evidence for the traditional and reconstructed models of water-level change and for anomalies in the regional pollen succession, and show their effect on the Sheguiandah archaeological site. The pollen anomalies are considered in relation to fluctuations in the spruce-pine ecotone across the Great Lakes region and are reinterpreted in light of recent revisions to the history of the Great Lakes (Rea *et al.* 1994a, b; Lewis *et al.* 1994; Moore *et al.* 1994, 2000). Ecotone boundaries, such as the spruce-pine ecotone, are sensitive to climate change (Wright 1976; Liu 1990) and northward/southward displacement of such an ecotonal boundary is clear indication of climate change. We combine the lake level data and pollen records to derive the optimum conditions and timeframes for early human occupation of the Sheguiandah site.

Previous archaeological and geological studies at the Sheguiandah site were undertaken in the 1950's by Lee (1957) and Sanford (1957). Terasmae (Lee 1957) did a pollen study of one of the swamps (Swamp 3) adjacent to the archeological site. Later, Lee (1986) summarized the relevant issues and offered evidence and arguments supporting human presence at Sheguiandah at more than 30 000 years ago (see also Barnett; von Bitter; and Julig and Mahaney, this volume for related research arising from the 1990/91 re-investigations).

Regional / Local Setting

Physiography and Bedrock Geology

The upper Great Lakes region refers to and includes the lake basins of Lake Superior, Lake Michigan, Lake Huron and Georgian Bay. Lake Huron and Georgian Bay lie within the Western St. Lawrence Lowlands physiographic region whereas Lake Superior is in the James physiographic region as defined by Bostock (1970). The region is bordered on the north by contiguous highlands of the Canadian Shield where elevations rise over 650 m A.S.L. The south-central Great Lakes region comprises relatively flat relief with the exception of disjunct highlands reaching over 450 m A.S.L. to the east, southeast and southwest (Figure 8.1).

Figure 8.1. Map showing five south-north traverses intersecting pollen sites across the Great Lakes and lake-level sites in the northern Lake Huron - eastern Georgian Bay region. Dotted line is the 305 m elevation contour. Major forest regions are indicated (F&P = Forest and Prairie; DF = Deciduous Forest; MF = Mixed Forest; BF = Boreal Forest). Inset map (top left) shows study area.

Palynology sites: 1. Maplehurst Lake (Mott and Farley-Gill 1978); 2. Edward Lake (McAndrews 1981); 3. Strain Lake, 4. Plate Lake, 5. Lake near Orrville, Ontario (this Study); 6. Lac Bastien (Bennett 1987); 7. Chippewa Bog (Bailey and Ahearn 1981); 8. M17 site (Lewis and Anderson 1989); 9. Kincardine Bog (Karrow *et al.* 1975); 10. Sheguiandah site (Anderson, this volume); 11. Greenbush Swamp (Warner *et al.* 1984); 12. Nina Lake (Liu 1990); 13. Wintergreen Lake (Manny *et al.* 1978); 14. Vestaburg Bog (Gilliam *et al.* 1967); 15. Lake Sixteen (Futyma and Miller 1986); 16. Upper Mallot Lake (McAndrews and Campbell 1993); 17.Disterhaft Farm Bog (West 1961; Bender *et al.* 1971); 18. Seidel Lake (West 1961); 19. Wood Lake (Heide 1984); 20. Lake Mary (Webb 1974); 21. Cummins Pond (Julig *et al.* 1990); 22. Kirchner Marsh (Wright *et al.* 1963); 23. Jacobson Lake (Wright and Watts 1969); 24. Weber Lake (Fries 1962); 25. Myrtle Lake (Janssen 1968); 26. Rattle Lake (Björck 1985); AL-Alfies Lake (Saarnisto 1975); BB-Bucyrus Bog (Shane 1989); BL-Barry Lake (McAndrews 1984); CL-Charles Lake (R. Bailey, per. comm. 1973); CRL-Crystal Lake (Walker and Hartman 1960); HCL-Hudson and Clear Lakes (Bailey 1972); JL-Jacobson Lake (Wright and Watts 1969); PL-Pretty Lake (Williams 1974); PS-Pile site (Shane 1987); QL- Quadrangle Lake (Terasmae 1967); QS-Quillin Site (Shane 1987); RL-Ring Lake (McIntyre *et al.* 1991); SL-Stotzel-Leis (Shane 1987); TL-Tonawa Lake (McAndrews and Campbell 1993); THL-Thane Lake (Terasmae 1967); VB-Volo Bog (King 1981); VR-Victoria Road Bog (Terasmae 1968; Anderson 1995); WL-Weslemkoon Lake (Edwards and McAndrews 1989).

Lake-level Analysis sites (inset map top right): 1. Kincardine Bog; 7. Hope Bay; 8. Greenbush Swamp; 9, b,c. Sheguiandah Bog; 10. Lake Sixteen; 12. Upper Twin Lake; 13. Prince Lake; 23. Tehkummah Lake; 27. Boulter Tp. Lake; 28 a,b. Straits of Mackinac; 29 a,b. Bruce Mines Bog; 33. Wood Lake; 34. Smoky Hollow Lake; 40. Flummerfelt Patch; 41. Tanner Lake; 42. South Bay; 43. Blind River Bog; 44. Wolseley Bay Lake; 49. Amable du Fond River; 50. Pure Lake; 66. Bad Neighbour Shoal; 67, 68a,b, 69. Lucas Island Channel; 70, 71. Cassels Cove Island; 72. Wye Marsh. FP-Flowerpot Island, WH-Whitefish Sill, DA-Dalles Sill, NBO-North Bay Outlet.

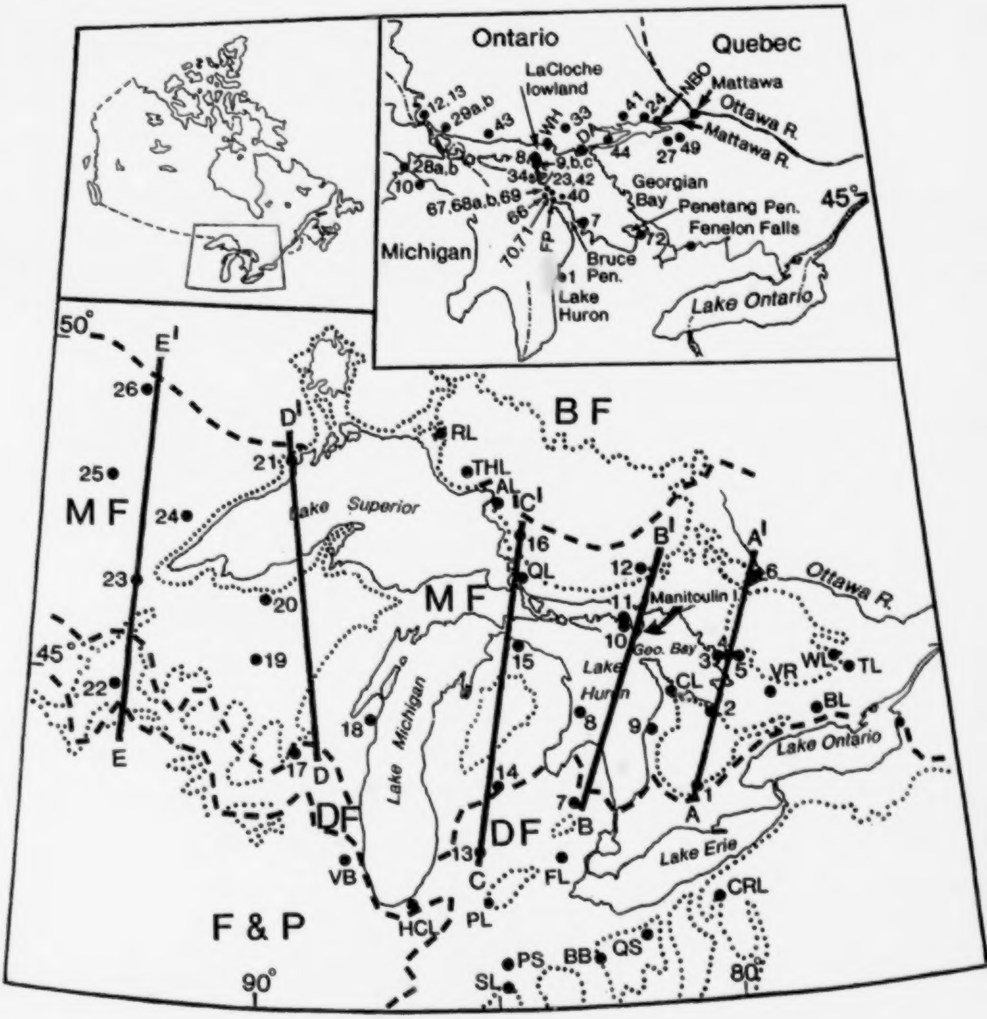

Ontario
Quebec
LaCloche lowland
12,13
29a,b
43
WH
33
DA
41
24
NBO
Mattawa
Ottawa R.
Mattawa R.
44
27
49
8
9,b,c
28a,b
10
34a
23,42
40
67,68a,b,69
66
70,71
FP
7
Georgian Bay
Penetang Pen.
Fenelon Falls
72
45°
Michigan
1
Bruce Pen.
Lake Huron
Lake Ontario
50°
E'
26
D'
21
BF
RL
THL
AL
C'
25
MF
24
Lake Superior
16
B'
A'
12
6
Ottawa R.
23
QL
20
MF
11
Manitoulin I.
10
Geo. Bay
45°
19
15
Lake Huron
4
3
5
VR
WL
TL
22
CL
2
BL
18
Lake Michigan
8
9
Lake Ontario
E
17
D
14
1
7
A
B
DF
DF
13
FL
Lake Erie
VB
C
CRL
PL
F & P
HCL
QS
PS
BB
90°
SL
80°

Figure 8.1. (Caption on opposite page).

Paleozoic sedimentary rocks underlie the Michigan and Huron lake basins; Georgian Bay straddles the contact between the Paleozoic and the Precambrian metamorphic rocks of the Canadian Shield (Hough 1958). Except for Cambrian sedimentary bedrock beneath its eastern southern shore, Lake Superior lies completely within Shield rocks.

The Sheguiandah site is in eastern Manitoulin Island on the upper slopes of a knob of Precambrian quartzite at elevations within 10 m of its summit altitude of 224 m A.S.L. The quartzite was exposed by erosion of surrounding dolostones of the Lower Silurian Manitoulin Formation and Upper Ordovician Kagawong Formation. These strata and the Silurian dolomitic rocks (Amabel Formation), which form the Niagara Escarpment about 15-20 km south of Sheguiandah, comprise most of the bedrock on Manitoulin Island. All strata dip gently southward to southwestward beneath Lake Huron into the Michigan Structural basin (Hough 1958; Chapman and Putnam 1984; Johnson *et al.* 1992; see also von Bitter, this volume).

Surficial Features

Southwesterly moving glacial ice and subglacial meltwater scoured the rock surface resulting in thin to non-existent surficial deposits in most places (Sly and Lewis 1972; Chapman and Putnam 1984; Kor *et al.* 1991). As the glaciers receded, Manitoulin Island was almost totally inundated by glacial Lake Algonquin and partially flooded by the post-Algonquin and Mattawa lake phases and the Nipissing Great Lakes. Raised shorelines and sediments of these lakes are prevalent in many areas on the Island. Near Sheguiandah, the Algonquin shore is found at 309 m A.S.L. (Stanley 1934) and the Nipissing shore at 198 m A.S.L. (Lewis 1970). The shorelines are tilted to the north-northeast by glacial rebound and indicate that northern Manitoulin Island has been uplifted relative to southern Lake Huron by about 125 m since Main Lake Algonquin (~10.7 ka BP) and about 14 m since the Nipissing Great Lakes (~5 ka BP) (Hough 1958; Lewis and Anderson 1989; Lewis 1970; see also Barnett, this volume).

Vegetation and Climate

Manitoulin Island is situated in the Great Lakes-St. Lawrence Forest Region and the Huron-Ontario Forest Section of Rowe (1972) and therefore is a transition area between the Boreal Forest to the north and the Deciduous Forest to the south (Figure 8.1). Forest and woodland form the natural vegetation cover and dominate the landscape except for areas cleared for agriculture (Morton and Venn 1984). The mixed softwood forest and woodland components include characteristic boreal forest species which dominate the more exposed and cooler locations. The deciduous hardwood forest and woodland components are dominated by upland sugar maple, birch and beech but include valley hardwoods, soft maple swamp and mixed forest swamp which collectively dominates the inland less-exposed areas. The regional climax forest of the central Great Lakes is an *Acer saccharum-Fagus grandifolia* (sugar maple-beech) association.

The climate of the upper Great Lakes region including Manitoulin Island is mainly influenced by high- and low-pressure weather systems, the ameliorating effect of the Great Lakes and topography (Phillips and McCulloch 1972). In the summer, the Great Lakes region is affected by warm/humid Pacific air masses from the southwest, cool/drier air from the north, hot/humid Gulf of Mexico air from the south and minor proportions of moist maritime air from the Atlantic Ocean. In the winter, the dominant air is cold and dry as it originates out of the Arctic. The relatively low relief of the south-central Great Lakes region allows the unobstructed movement of westerly winds from the west across the Great Lakes which result in increased moisture (local snow belts and highest mean annual precipitation) in the lee areas bordering the lakes, i.e., east side of Georgian Bay, east and southeast margins of Lake Huron including Manitoulin Island and the east side of Lake Superior (Phillips and McCulloch 1972). The higher moisture indexes are locally reflected in the forest cover as these areas feature the prominent distribution of tolerant hardwoods in the uplands with a varying admixture of mixed-woods and softwoods in the lowlands. However, drought-prone areas prevail in the lee of the high moisture areas, i.e., east of the Dundalk Uplands of south-central Ontario where longer dry periods are experienced especially during summer months than in other regions of Ontario (Brown *et al.* 1968).

Locally, the onshore winds keep the south shore of Manitoulin Island cool while the interior experiences hot summer conditions; these effects are reversed during autumn and winter. The local effects are reflected in the distribution patterns of many plants and in the vegetation (Morton and Venn 1984). For example, species of arctic plants (*Draba glabella, Eriophorum vaginatum, Poa glauca* and *P. alpina*) occupy areas exposed to the lake where they experience the cooling effect of the Great Lakes. Southern species (*Decoden verticillatus, Viola Canadensis,* and *Peltandra virginica*) prefer the more sheltered interior areas which have comparatively long growing seasons and where the lake effect is less pronounced.

Databases and Methods

Palynology

Pollen records from sites in and bordering the Great Lakes form the palynology database in this study (Figure 8.1). The sites are published percentage diagrams from Ontario, the lake states of New York, Pennsylvania, Ohio, Indiana, Illinois, Wisconsin and Minnesota and Lake Huron and Georgian Bay. Key sites have been selected after a thorough examination and assessment of all pollen diagrams from the region. The sites fall into two groups, those showing a unidirectional pollen succession with no obvious change from the normal sequence and those exhibiting short-term changes or revertances in the pollen records. Figure 8.2 (a, and b) shows simplified pollen diagrams of the original diagrams of sites representing the two groups. The diagrams constitute five north-south transects across the upper Great Lakes. They contain only major taxa that best reflect normal vegetation succession or changes in the normal succession, which for most of the sites, are fluctuations in the percentages of *Picea* (spruce) and *Pinus* (pine). Reference radiocarbon dates are uncorrected except for those that have been ^{13}C-adjusted. Sites that fall within the range distribution of *Tsuga* (hemlock) have their dates checked against the 4.8 ka estimate for the hemlock pollen decline (Davis 1981).

Lake-Level Analysis

In the Great Lakes region, lake-level indicators of a former lake surface, initially all at the same level, are now found at diverse altitudes because postglacial isostatic rebound is differential and has uplifted them to different elevations. The uplift is greater in the direction of ice retreat

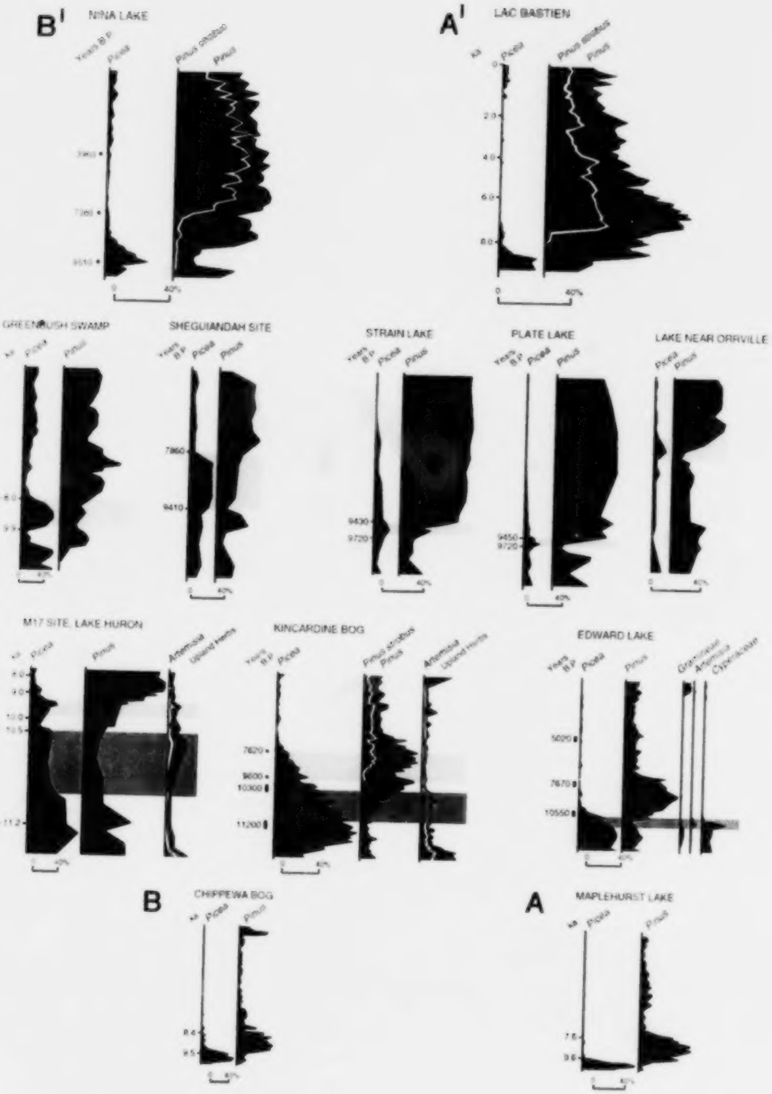


Figure 8.2a. *Picea*, *Pinus* and *Quercus* pollen successions from selected sites in south-north transects across the Great Lakes. Dark grey band represents the 11 - 10.5 ka pollen anomaly; light grey band is the 10 - 7.5 ka pollen anomaly. Dates (years BP) are indicated where available; otherwise ages (ka) are estimated from rates of sedimentation and pollen correlation.

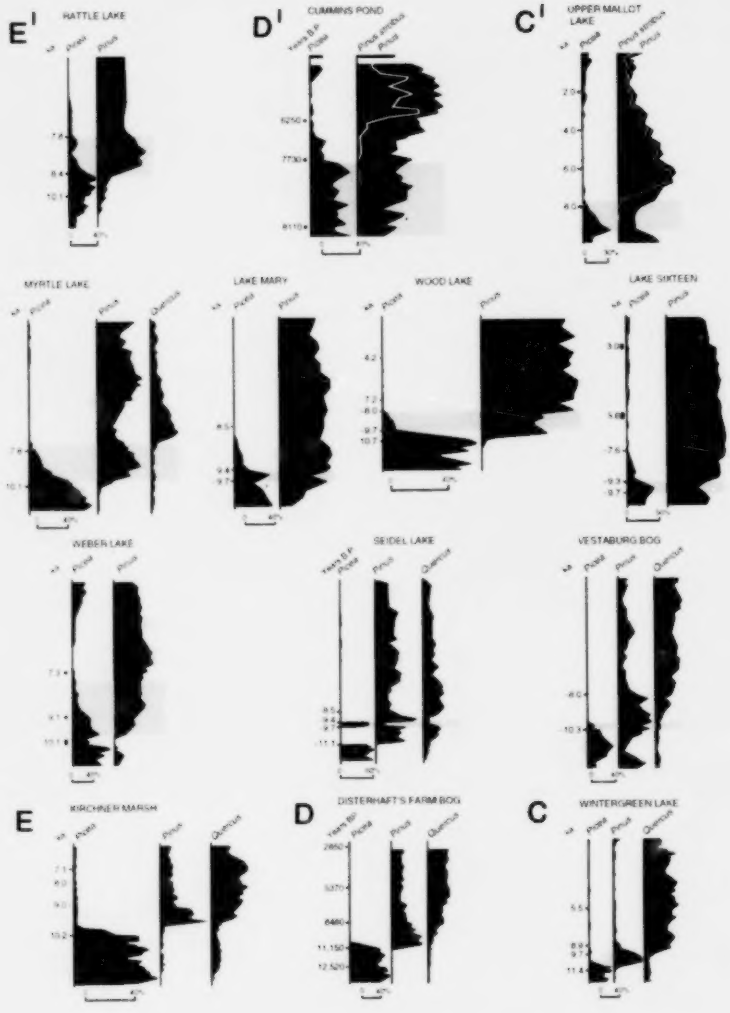


Figure 8.2b. *Picea*, *Pinus* and *Quercus* pollen successions from selected sites in south-north transects across the Great Lakes. Dark grey band represents the 11 - 10.5 ka pollen anomaly; light grey band is the 10 - 7.5 ka pollen anomaly. Dates (years BP) are indicated where available; otherwise ages (ka) are estimated from rates of sedimentation and pollen correlation.

and thicker ice towards the north-northeast. This makes correlation of indicators and interpretation of former water levels difficult and less than straightforward. We derive the water level history from an analysis of available radiocarbon-dated lake-level indicators after they have been re-plotted on a graph of elevation vs. age in their original altitudes by removing the uplift they have experienced since their formation. The advantage of this analysis is that indicators of a former water surface in different parts of the basin plot at the same elevation at the time of their origin. This facilitates the interpretation of lake-level history. In essence, all the curves on the plot (Figure 8.3) are uplift histories of the indicators, each rising toward its present elevation.

The uplift history for the Huron-Georgian Bay basin is determined by the present configuration of the differentially uplifted Algonquin and Nipissing shores — two prominent datums whose isobases have been compiled by Walcott (1972) and Lewis and Anderson (1989) among others. The isobases are based on elevation measurements of geomorphic shore features, such as wave-cut bluffs and terraces, beaches, spits, and barriers, reported by Goldthwait (1908, 1910), Leverett and Taylor (1915), Stanley (1936, 1937a, 1937b), Deane (1950), Chapman (1954, 1975), Hough 1958), Farrand (1960), Lewis (1969, 1970), Harrison (1972), Karrow (1980, 1986, 1987), Futyma (1981), Chapman and Putnam (1984), Cowan (1985), Farrand and Drexler (1985), Finamore (1985), and Kaszycki (1985). The Algonquin and Nipissing shores are assumed to approximate synchronous formation at 10.6 ka and 5 ka, respectively, based on the available radiocarbon age data (Lewis 1969; Karrow *et al.* 1975; Karrow 1980; and summaries of age data in Lewis and Anderson 1989). Alternate models for proglacial lake sedimentation suggest the Algonquin shores were transgressive south of, and regressive north of, the Kirkfield-Fenelon Falls area with implications of age variations in the classic Main Algonquin shore (Kaszycki 1985). Nonetheless, our assumption of a 10.6 ka uplift datum is believed to hold given the spatial distribution and variation in the available sparse radiocarbon age control. A different reconstruction of the Algonquin lake phases, involving sequential "Algonquin-level" lakes in the Huron and Michigan basins, has been obtained by using the trends of historically-monitored crustal movement (Larsen 1987) which are oriented slightly more northwesterly than the traditional Algonquin and Nipissing isobases. We prefer to use the latter for reconstruction of early to middle Holocene lakes as they contain information about the greatest amount of glacio-isostatic uplift which mostly occurred in the millennia following deglaciation; the effects of the greatest uplift are not embodied in the historic records which are less than two centuries in length.

Uplift is assumed to have proceeded at a smoothly decelerating rate that is described by an exponential decay expression of the form:

$$\text{Relative uplift or shoreline slope} = A\,(\exp(t/\tau)-1) \qquad (1)$$

Where t is the time elapsed since formation of the former lakeshore or other water level indicator, τ is the relaxation time of the uplifting process and A is an amplitude factor specific to each indicator site (Peltier 1994; Tackman *et al.* 1998). Exponential relaxation fits the uplift data in the northern Great Lakes basins well for the time period studied in this report (Lewis and Anderson 1989). After 5-4 ka, it has been noted that the relationship of vertical crustal movement with time is indistinguishable from a linear function (Lewis 1970; Larsen 1994).

The two parameters of equation (1) are obtained by evaluating the expression where two shorelines of different age, the Algonquin and Nipissing, exist at a specific site. A value for τ =

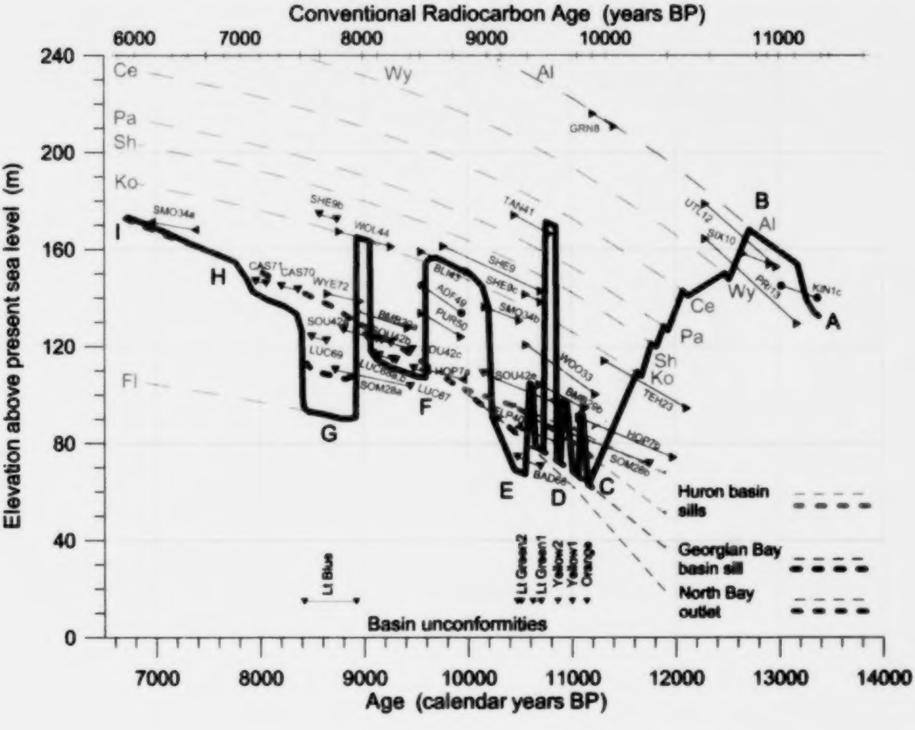


Figure 8.3. Lake surface variations in the Georgian Bay and Huron basins (thick solid blue line) 13,400 to 6700 calendar years BP (11.4 - 6.1 ka) based on all available data. During the lowstand at G (8900-8400 cal BP), the solid blue line indicates water level at the Flowerpot submerged beach in Georgian Bay, and the dashed blue line indicates the maximum possible water surface in Huron basin. The major lake phases illustrated by this figure are: A - Kirkfield Algonquin, B - Main Algonquin, C - early Stanley lowstand, D to E - Early Mattawa highstand, E - mid-Stanley lowstand, E to F and F to G - Main Mattawa highstands, G - late Stanley lowstand, and H to I - Nipissing transgression (based on interpretations by Lewis and Anderson 1989; Moore *et al.* 1994; Rea *et al.* 1994; Lewis *et al.* 1994 and this paper). Also shows uplift histories for basin outlets (red, green, and purple dashed lines) and selected paleoshorelines (grey long-dashed lines).

3700 ± 700 calendar years was obtained by averaging the results of this evaluation at several sites throughout the Great Lakes region (Gareau *et al.* 2001). A standard relative uplift surface for 10.6 ka (12,800 cal BP) was established for the region relative to a site outside the glacial limit southwest of southern Lake Michigan based on the Algonquin shore isobases and isobases of other up-warped glacial lake shorelines in the Michigan basin (Gareau *et al.* 2001). Example standard uplift values (post 10.6 ka, 12,800 cal BP) for eastern Manitoulin Island range from 149 m near Little Current, to 141.5 m near Sheguiandah, to 117 m near South Bay.

An uplift or elevation history for any desired site is obtained by using the foregoing value for τ and the standard relative uplift for the site. Equation (1) is rearranged to solve for the amplitude factor A_s at the desired site:

$$A_s = \text{site standard relative uplift} / (\exp(12\,800/3700)-1) \tag{2}$$

Then uplift U_t for the site since any age $t = A_s(\exp(t/3700)-1)$ where t is expressed in calendar years BP. Finally, the elevation E_t of the site at age t is found by subtracting the uplift achieved since t from the present site elevation, E_p, that is

$$E_t = E_p - U_t \text{ or } E_t = E_p - A_s(\exp(t/3700)-1) \tag{3}$$

Several kinds of data are plotted in Figure 8.3 as a basis for inferring changes of water level: former shorelines, basin unconformities, outlet elevation history, *in situ* tree stumps, and clastic/organic sediment transitions in small lake and bog basins caused by large lake inundation or emergence. The uplift trajectories for 6 former shorelines on the east-facing slope of Manitoulin Island near the Sheguiandah archeological site are illustrated as grey long-dashed curves in Figure 3 labeled as: Al, Algonquin; Wy, Wyebridge; Ce, Cedar Point; Pa, Payette; Sh, Sheguiandah; and Ko, Korah. The Algonquin shore elevation was measured by Stanley (in Hough 1958, p. 232); the others were surveyed by Hough (1958, p. 232-233). A seventh shore, the Flowerpot palaeo-beach (Fl) now 52 m below Georgian Bay near Flowerpot Island (Blasco 2001), is also illustrated. The ages of the lakes which formed these shores are not yet determined, except for the 10.6 ka age of the Algonquin beach explained previously, although some post-Algonquin shore ages are estimated later from the relationship of their slopes to that of the Algonquin shore. The crest of the hill bearing the Sheguiandah archeological site probably fell just below the surface of the Sheguiandah lake phase (Hough 1958). The upward trajectories of these shore features (and all other sites) reflect glacio-isostatic uplift relative to the driftless area southwest of southern Lake Michigan (Gareau *et al.* 2001).

The age of basin unconformities and their correlative conformities, named for colours, are shown near the base of the plot. These are identified in the seismostratigraphy and dated by cores of the offshore sediments in the Huron and Georgian Bay basins. They are sequence boundaries which were formed during episodes of lowered lake level (Moore *et al.* 1994; Rea *et al.* 1994a). The radiocarbon ages of the unconformities are based on ostracode valves corrected for hardwater effect and calibrated with the 1998 ^{14}C atmospheric dataset (Stuiver *et al.* 1998; Moore *et al.* 2000). All other data in the plot have been calibrated with the new Calib 4.3 program (Stuiver and Reimer 1993) also using the 1998 dataset (Stuiver *et al.* 1998). The calendar time scale is important for providing a linear scale for computation of uplift. Also, it eliminates the distortions of the radiocarbon scale to show the actual temporal distribution of level changes, especially in the 7.5 - 11.8 ka period which spans the largest and least understood changes in the Huron-Georgian Bay basin.

The outlet elevation histories are shown by the red, green and purple dashed lines (Figure 8.3). The paleo-drainage after Main Lake Algonquin until 5 ka was eastward through the Huron and Georgian Bay basins, and the lowland leading to the North Bay outlet to the Mattawa and Ottawa rivers. The thicker segments of the dashed coloured lines indicate times when the indicated outlets could have been water-level controls for overflowing lakes in the Huron basin (thick dashed green line), and Georgian Bay basin (thick dashed purple lines), then for a combined lake in both basins impounded by the North Bay outlet (thick dashed red line). Only the extremes of the Huron basin sills are shown, the Whitefish sill (filled diamonds) in the northern part of the LaCloche lowland north of Manitoulin Island, and a sill near Flowerpot Island in the southern part of the Deane-Tovell saddle trending between Bruce Peninsula and Manitoulin Island, and dividing the Huron and Georgian Bay (Figure 8.1) (Lewis and Anderson 1989). The Dalles outlet threshold for the Georgian Bay basin, in the lower French River near the northeastern corner of Georgian Bay (Figure 8.1), is shown with filled squares while the Nipissing beach elevation at the North Bay outlet is indicated by the filled circles. The Nipissing beach is approximately 10 m above the sill of the North Bay outlet. Note that the Sheguiandah site is affected by Georgian Bay water levels as it lies east of the Huron basin sills on the LaCloche lowland.

Tree stumps preserved on the lakebed in growth position have long been known from the Straits of Mackinac area (sites SOM28a and SOM28b listed in Lewis and Anderson 1989) and require the lake level to have been drawn down below their roots during their lifespan. Additional tree stumps in growth position have been discovered on the lakebed in the Deane-Tovell saddle area north of the Bruce Peninsula. The dated stumps are plotted at the BAD66 (Bad Neighbour Shoal), LUC67-69 (Lucas Island Channel), and CAS70-71 (Cassels Cove Island) sites (Blasco *et al.* 1997; Blasco 2001) with a downward-pointing open triangle symbol. All radiocarbon-dated sites are plotted with a line joining two open symbols, representing the plus to minus one-sigma uncertainty values of the calibrated calendar age as determined in the Calib 4.3 calibration program. The site name, consisting of three letters and numerals, is superimposed on the older symbol except where its position was adjusted to avoid overlap with adjacent site names.

Most other plotted sites are radiocarbon-dated sediment boundaries observed in cores from small lake or bog basins (such as Sheguiandah bog) above the present Great Lakes or small basins beneath Lake Huron and Georgian Bay which were once isolated from the large lake. The numerals in the site names are keyed to the entry numbers for date listings up to number 50 in Lewis and Anderson (1989) or Lewis *et al.* (1994) where more information about the dated material and its setting can be found. Only ages determined on wood, plant material or algal sediment (gyttja) were selected for the plot. Dates at the base of organic peat or gyttja over clastic sand, silt or clay (right-pointing open triangle symbols) are inferred to mark the emergence of a small lake basin or bog from the effects of sediment-transporting water and waves during a regression of the more extensive Lake Huron-Georgian Bay (Lewis 1970). A reverse stratigraphy of clastic sand, silt or clay over organic sediment is interpreted to indicate submergence of a small lake or bog basin by transgression of a large lake (left-pointing open triangle symbols as at SMO34a and HOP7a). Sites with open circle symbols indicate where water level was at or passed through the site locale at the time the dated organic sediment was deposited. The WYE72 site near Midland is dated pine wood at the base of Wye marsh organic sediment over laminated clay (Chittenden 1990).

Upper Great Lakes Water-Level Changes 11-7 ka

Interpretation of the Lake–Level Curve

From A to B in Figure 8.3, relative lake level in the Huron-Georgian Bay basin, shown as a thick solid blue line, rose from the Kirkfield Algonquin to the Main Algonquin phase, transgressing the plant detritus bed at Kincardine (KIN1c) (Karrow *et al.* 1975; Eschman and Karrow 1985). From B to C, lake level dropped from the Main Algonquin level, regressing in succession from small lake basins at Upper Twin Lake (UTL12), Lake Sixteen (SIX10) and Prince Lake (PRI13) (summarized in Lewis and Anderson 1989). The subsequent descent is marked by brief stops at the post-Algonquin shorelines. The post-Algonquin lake-level descent to Early Lake Stanley-Hough continued below the basin of Tehkummah Lake (TEH23) on Manitoulin Island, then below the present level of Lake Huron and Georgian Bay where emergence of the lakebed induced peat accumulation at the Hope Bay site in Georgian Bay (HOP7b), and tree growth in the Straits of Mackinac (SOM28b). Lake Stanley is the lowstand in the Huron basin and Lake Hough is the correlative lowstand in the Georgian Bay basin; here they are referred to jointly as Lake Stanley-Hough.

The ages for three post-Algonquin shorelines were estimated using equation (1) and shoreline data given by Stanley (1936) for the Penetang region of southern Georgian Bay. Using the Algonquin shoreline slope of 0.640 m/km (3.38 ft/mi) in Stanley (1936) with assigned age of 12,800 cal BP (10.6 ka) and relaxation time $\tau = 3700$ years, the A factor for Penetang is computed as *slope* (0.640 m/km)/(exp(t/τ)-1) or 0.02078. Then by taking the natural logarithm of both sides of equation (1) and rearranging terms:

$$\mathrm{Ln}\,(\mathit{slope}/A) = (t/\tau)-0 \text{ or } t = 3700*\ln(\mathit{slope\ in\ m/km}/\ 0.02078) \qquad (4)$$

By substituting shoreline slopes in m/km converted from Stanley (1936, Table 3 and Figure 2) in equation (4), ages were obtained for the Wyebridge (12,510 cal BP), Cedar Point (12,080 cal BP), and Payette (11,920 cal BP) lake phases. These ages and an allowance of decades to a century for formation of each of the post-Algonquin shorelines on Manitoulin Island, control the course of the lake-level curve in Figure 8.3.

The basal gyttja date at Greenbush swamp (GRN8) just below the Algonquin shore on northern Manitoulin Island (Warner *et al.* 1984; Hough 1958) appears as an outlier on the lake-level plot though its uplift trend projects back to the cluster of Algonquin-age sites near B. This could mean that organic sedimentation was delayed until 11,350 cal BP (10 ka) because this high site was occupied by local residual ice or received inorganic sediment by local slope wash for a millennium or longer.

The lake-level descent to C is recorded in offshore Huron-Georgian Bay sediments as the Orange unconformity (Moore *et al.* 1994, 2000). Two additional transgressions and regressions are inferred between C and D from the Yellow 1 and Yellow 2 unconformities in the offshore basin sediments. No constraints are recognized yet for the amplitudes of these rises. If minor, as shown, they would have flooded South Bay, but not the Bruce Mines bog (BMB29b) where peat accumulated.

From D, a pronounced lake-level rise to the Early Mattawa phase inundated the South Bay (SOU42e), Smoky Hollow Lake (SMO34b) and Sheguiandah Bog (SHE9, SHE9c) basins on Manitoulin Island as well as the higher Tanner Lake basin (TAN41) between Sudbury and North Bay (Lewis and Anderson 1989). The subsequent lake fall, about 100 - 150 years later, to the mid-Stanley lowstand formed the Light Green1 unconformity and established emergent, small-basin conditions at Tanner Lake, Sheguiandah Bog, Smoky Hollow Lake, and Wood Lake. Below the present level of Lake Huron-Georgian Bay, marsh conditions were initiated at South Bay (SOU42e) (Lewis and Anderson 1989). A small lake rise apparently permitted offshore sediment deposition after the Light Green1 unconformity before lake level fell again to the Light Green 2 unconformity at E, inducing emergent conditions on the Deane-Tovell saddle for the accumulation of terrestrial peat at Flummerfelt Patch (FLP40) (Lewis and Anderson 1989), and tree growth near Bad Neighbour Shoal (BAD66) (Blasco *et al.* 1997; Blasco 2001).

From E, lake level rose to the Main Mattawa highstand, culminating at the Blind River bog site just short of inundating the slightly higher Sheguiandah bog site (SHE9, 9b, 9c) (Lewis and Anderson 1989, this study). Shorelines formed by the Mattawa highstands are not yet recognized. The water levels were likely highly variable as they are thought to have been supported by Agassiz drainage episodes of high discharge through a hydraulic constriction in the Ottawa River valley downstream from Mattawa (Lewis and Anderson 1989). Closer to North Bay, the Main Mattawa rise induced sand aggradation in the Amable du Fond River (ADF49) and brought clay into Pure Lake (PUR50). It is suggested that by this time, large glacial lakes Agassiz and Ojibway were discharging via the Ottawa River; during times of increasing flow, water levels rose upstream of the Ottawa valley constriction and backflooding waters with sediment plumes moved west through the North Bay lowland carrying fine-grained sediment into basins such as Pure Lake.

The fall at F from the Main Mattawa highstand leading to regression and emergence of the former lakebed is evidenced by peat accumulation at Bruce Mines bog (BMB29a), marsh sediment at South Bay (SOU42c plant detritus and the unlabelled SOU42a and b which are confirming seed dates) (Lewis *et al.* 1994), and tree growth on the Deane-Tovell saddle (LUC67 and 68a, b) (Blasco *et al.* 1997; Blasco 2001). A distinct unconformity in offshore basin sediments related to this lake-level decline has not yet been recognized, or possibly the onset of the Light Blue unconformity should correlate with this decline.

From F, lake levels remained low enough to allow tree growth at the Lucas Island Channel (LUC) sites, and marsh sediment accumulation at South Bay before rising about 9050 cal BP to inundate Wolseley Lake (WOL44) and many other sites (not shown) in the lowland between Georgian Bay and North Bay. This last rise to the Mattawa highstand stopped short of inundating the Sheguiandah bog site where peat continued to accumulate (SHE9b). About 8900 cal BP, lake levels fell again to form the Light Blue unconformity. An alternative interpretation could apply if inorganic basal sediment in the WOL44 basin were introduced by the preceding Main Mattawa highstand. Then the lowstand at F could continue into the lowstand at G without an intervening lake rise between 9050 and 8900 cal BP.

The low water level at G is interpreted at the Flowerpot beach level in Georgian Bay in accordance with the age of the Light Blue unconformity. The lake in Huron basin could have been higher but no higher than the tree growth in the Straits of Mackinac (SOM28a). These levels were well below the Huron and Georgian Bay outlet sills, and the lakes must have been hydrologically closed, signifying a period of dry climate (Blasco *et al.* 2001). The low lake levels correlate with the return of *Pinus* domination dated 7880 BP at Sheguiandah (Anderson, this volume). This second *Pinus* domination, supported by increases in hardwoods, such as oak, elm, beech, ash, basswood and first occurrence of hemlock suggest a change to a warm-dry regional climate when July mean temperatures increased abruptly by as much as 2.6E and precipitation decreased about 200 mm per annum between 8 and 6 ka at Upper Mallot Lake (McAndrews and Campbell 1993; J.H. McAndrews, personal communication, 2001).

Lake level rose from the late Stanley-Hough lowstand (G) at the end of the period in which the Light Blue unconformity was formed, but remained below the North Bay outlet level until H as indicated by the presence of tree stumps now deeply submerged on the lakebed (LUC69, CAS70 and 71) (Blasco *et al.* 1997; Blasco 2001). From H to I the relative lake level rose in the basin following the more rapidly uplifting outlet at North Bay. The rising waters backflooded the sill of Smoky Hollow Lake on Manitoulin Island, where an influx of clastic sediment overwhelmed biogenic production (SMO34a) (Lewis 1969). This transgression continued until discharge began to flow southward at Port Huron and Chicago. The strongly developed Nipissing shore was formed throughout the upper Great Lakes basins during this transition between 5.5 and 4.6 ka.

Lake-level Concept Development for the Huron-Georgian Bay Basin

Awareness of the former presence of a high-level waterbody in the Georgian Bay basin whose shorelines were subsequently up-warped to the north-northeast came in the nineteenth century with the recognition of the deformed "Algonquin Beach" by Spencer (1891). Goldthwait surveyed the elevation of this shore and others throughout the Michigan and Huron-Georgian Bay basins (1908, 1910). Taylor (1897) discovered the Nipissing beach and the outlet at North Bay by which the upper Great Lakes drained to the Mattawa and Ottawa rivers after Lake Algonquin. The prevailing view of lake history for the first third of the twentieth century saw Lake Algonquin draining southward via the Port Huron outlet while ice dammed the North Bay outlet (Leverett and Taylor 1915). Beaches below the main Algonquin shore were thought to have formed as uplift raised the basin differentially (greater uplift to the north-northeast) while drainage continued at Port Huron. When ice retreated from the Mattawa-Ottawa valley, the lake was drained to a level just slightly below the Port Huron outlet. Further differential uplift raised the North Bay outlet and the lake behind it until it again discharged southward; the well-formed Nipissing shoreline was constructed at this stage. Port Huron subsequently captured the entire southward overflow, first shared with the Chicago outlet to the Illinois River and then the Mississippi River draining to Gulf of Mexico.

A new view was formulated by Stanley (1936) based on his discovery that the post-Algonquin shorelines projected southward to levels well below the Port Huron outlet (at least 35 m). As a result, Stanley postulated that the post-Algonquin lake phases drained by the opening of successively lower outlets to the northeast culminating in an extremely low lake level, near sea level, when the North Bay outlet became active. Uplift of the North Bay outlet initiated the regional Nipissing transgression in the Huron-Georgian Bay and Michigan basins. This hypothesis was supported by Hough (1962) using observations of lithostratigraphy in cores collected from northwestern Lake Huron in which he found a silty unconformable zone within a deepwater clay-rich sediment sequence. Hough actually found three silty zones. The lower two were attributed to coarser sediment inputs from nearby ice marginal drainages. The third and upper zone was attributed to wave erosion in the post-Algonquin low-level lake which he named Lake Stanley in honour of Stanley's 1936 prediction. Hough had previously located similar evidence for a correlative low-level lake in the Michigan basin which he named Lake Chippewa (Hough 1955).

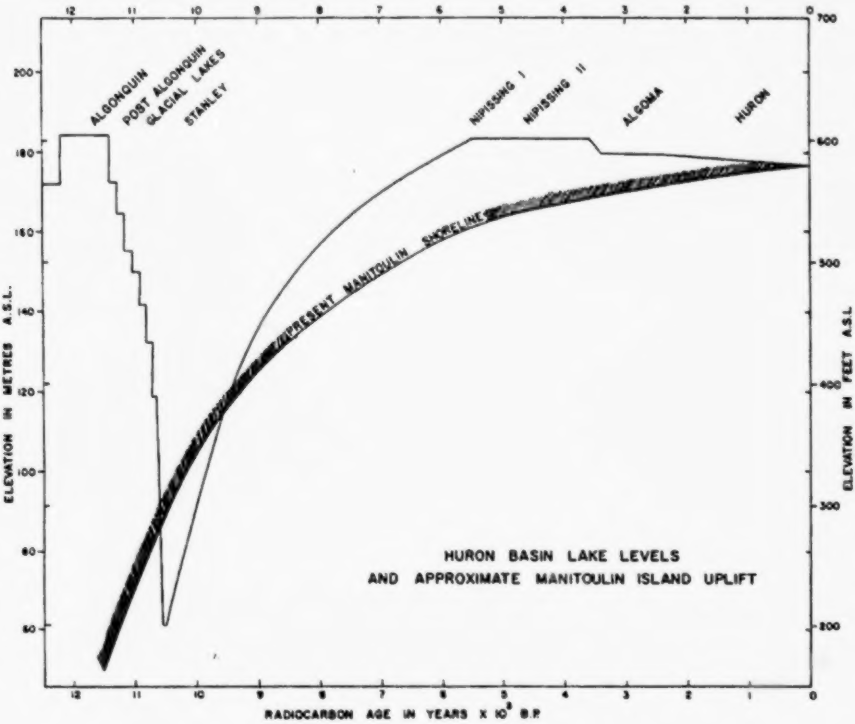


Figure 8.4. The Hough-Stanley model of lake-level change in the Huron basin adapted to show its interaction with Manitoulin Island (from Lewis 1969).

The Hough-Stanley concept provided for a high-level Main Lake Algonquin phase discharging via Port Huron to Erie basin following a lower level phase discharging via the Kirkfield outlet to Ontario basin. After Main Algonquin, lake level fell relatively quickly with short periods of stability and shoreline formation as new outlets were opened during ice retreat;

these were the post-Algonquin shorelines. Evidence for drainage routes from the post-Algonquin lakes across the highlands south of North Bay between Georgian Bay and the Ottawa river valley was found subsequently by Chapman (1954), Harrison (1970, 1972), and Ford and Geddes (1986). A final lowstand (Lake Stanley) was established when the North Bay outlet became active. Then relative lake level rose progressively towards the Nipissing Great Lakes phase before descending to its present elevation, as illustrated in Figure 8.4 for the Manitoulin Island area (Lewis 1969). Above its present shoreline with Lake Huron-Georgian Bay, Manitoulin would have been inundated only twice — during the Algonquin and post-Algonquin lake phases, and during the Nipissing transgression (up to about 198 m A.S.L.) and subsequent regression. This Hough-Stanley concept has been used by many others to explain lake level history (Chapman and Putnam 1984; Eschman and Karrow 1985; Barnett 1992; Barnett, this volume).

Hough thought Lake Stanley could not drain over the Huron basin rim north of Bruce Peninsula but instead used a lower route north of Manitoulin Island, then more depressed by the previous ice load (Hough 1962). In the early 1960s R.E. Deane and W.M. Tovell began seeking evidence that the submerged Niagara Escarpment north of Bruce Peninsula was an emergent sill during the Stanley low phase (Tovell 1978; W. M. Tovell, personal communication, 1994). Their insight and early findings that this was the case were borne out by subsequent work in the area (Blasco 2001) and as shown in the lake level history plot (Figure 8.3). For this reason we refer here to the underwater portion of the rim between the Huron and Georgian Bay basins as the Deane-Tovell saddle.

Anomalously young ages (8 ka) for the emergence of small lakes above the Nipissing shore which should have been exposed shortly after drainage of Lake Algonquin (10 ka or older) (Lewis 1969), and the recognition of two cycles of emergence/ submergence in South Bay (Anderson 1978) presented problems for the concept of a single Lake Stanley lowstand. Subsequently, Lewis and Anderson (1989) re-interpreted the then current data sets of water level indicators and their ages to show that episodic large inflows from upstream glacial Lake Agassiz induced substantial rises of lake level, the Mattawa highstands, between the first use of the North Bay outlet and the Nipissing Great Lakes phase.

Offshore studies by Moore *et al.* (1994) and Rea *et al.* (1994a) identified and related multiple unconformities in the seismostratigraphy of sediments in Lake Huron and Georgian Bay to episodes of lowered lake level. These supported and refined the sequences of alternating lowstands/ highstands inferred by Lewis and Anderson (1989). New sediment cores and dates in South Bay confirmed the earlier findings of Lewis and Anderson (1989), while new cores in northwestern Lake Huron confirmed the lithostratigraphy and the three silty zones reported by Hough (1962). However, Hough's interpretation of nearby ice marginal drainages is not now supported, the ice margin is now known to have retreated north to the eastern Superior basin by the time of the Huron basin lowstands (Lowell *et al.* 1999). Thus the three silty zones found by Hough signify three low lake phases and support the concept of three Lake Stanley lowstands (Lewis *et al.* 1994).

Chronological models for drainage of Main Lake Algonquin have varied since the advent of radiocarbon dating from as young as 8 ka (Hough 1958, Table 22) to as old as 11.5 ka (Harrison 1970, 1972; Prest 1970). The older age for ice retreat and lake drainage is derived from two bulk sediment age determinations of basal gyttja in 'Boulter Tp.' (Turtle) Lake on the southern margin of the Mattawa River outlet valley. Figure 4 from Lewis (1969) illustrates the older model. Karrow *et al.* (1975) established an intermediate age, about 10.4 ka, for the drainage of Lake Algonquin based on the dating of 6 plant and mollusk fossils in lagoon and estuarine strata associated with the transgression and regression of Lake Algonquin in the southwestern Huron and southern Georgian Bay basins. Both the older and intermediate age models are still in use, for example this paper and its predecessors favour the intermediate model, but continental-scale reconstructions of deglaciation and proglacial lake extent use the older model (Dyke and Prest 1987; Dyke 1996). The authors have recored 'Boulter Tp.' Lake (site 27, Figure 8.1) and replicated the lithostratigraphy reported by Harrison (1970, 1972). We obtained an AMS ^{14}C age (Anderson *et al.* 2001) about 2000 years younger on terrestrial plant seeds separated from the basal gyttja. This result indicates the Karrow *et al.* (1975) chronology is the most appropriate age model for the drainage of Lake Algonquin and the onset of subsequent lake phases in the Huron-Georgian Bay basin. However, it should be noted that not all bulk organic lake sediment dates are in error. For example, the new AMS determination for the base of gyttja at Sheguiandah (SHE9c) is in agreement within the one-sigma error range of the original bulk basal date (SHE9) (Figure 8.3) obtained by Lee (1957). Similarly the AMS redating of seeds in marsh sediment at the South Bay site agree with the original determination on a bulk sample of plant detritus (compare SOU42c with the two unlabelled AMS seed dates within the 42c error range in Figure 8.3).

Pollen Evidence in Transects Across the Upper Great Lakes

Figures 8.1 and 8.2 show five south-north transects of abbreviated pollen stratigraphy across the upper Great Lakes. Only the profiles of *Picea* and *Pinus*, and for some sites, *Quercus*, are shown here (Figure 8.2) as fluctuations in these taxa are good indicators of abrupt climate change in the Great Lakes region.

Transect A-A^1 extends across the eastern Great Lakes region from Maplehurst Lake (No. 1) in the south northward through southeast Georgian Bay to Bastien Lake (No. 6) in the north. Maplehurst Lake shows a sharp *Picea-Pinus* transition at 9.6 ka and *Pinus* continues uninterrupted to about 7.6 ka. Lac Bastien in the north contains a similar *Picea-Pinus* transition but here it dates well before 8 ka. Between Maplehurst Lake and Lac Bastien four sites in the eastern Georgian Bay area record two deviations from the normal pollen succession. Edward Lake (No. 2) shows a decrease in *Picea* and increase in herb pollen prior to 10.5 ka after which *Picea* gives way to *Pinus* dominance. Three sites in an east-west transect east of Georgian Bay show *Picea* peaking early within the *Pinus* domination. Dates at the bottom and top of the *Picea* peaks in Strain and Plate lakes (Nos. 3, 4) are almost identical at 9.7 and 9.4 ka, respectively.

Other key sites lie east of but are not included in the A-A^1 transect. Victoria Road (Figure 8.1), for example, shows a spruce recurrence commencing 9.6 ka whereas Barry, Tonawa and Weslemkoon Lakes (Figure 8.1), which are more eastward, show no evidence of a similar spruce recurrence.

Transect B-B^1 extends across the Lake Huron and Georgian Bay basins from Chippewa Bog (No. 7) in the south to Nina Lake (No. 12) in the north. At Chippewa Bog (No. 8) *Picea* gives way to *Pinus* shortly after 9.5 ka and *Pinus* dominates uninterrupted to about 8.4 ka. However, more northward in the transect, the M17 site (No. 9) and Kincardine Bog (No. 10) in the west and east sectors of Lake Huron basin, respectively, display two pollen anomaly intervals. The earlier interval is represented by an upward decrease in *Picea* (following maximum percentages dated 11.2 ka at Kincardine) and a corresponding increase in herb pollen shortly after 11.2 ka to prior to 10 ka. The second, younger interval is represented by a second increase in *Picea* and an aborted *Pinus* increase between 10 and 9 ka at M17 site, and lingering *Picea* and corresponding decrease in *Pinus* between 9.6 and 7.6 ka at Kincardine.

Like the M17 site in Lake Huron, two sites on Manitoulin Island (Greenbush Swamp and Sheguiandah) show additional evidence of the younger (10-7.5 ka) pollen anomaly as *Picea* increases to peak percentages within the *Pinus*-dominated interval. The peak is dated between 9.4 and 7.8 ka at Sheguiandah (No. 10) and between 9.9 and 8 ka at Greenbush Swamp. Yet at Charles Lake (Figure 8.1), which is on nearby Bruce Peninsula but not included in the B-B^1 transect, the *Pinus*-domination is interrupted by a spruce recurrence commencing considerably later, i.e., at 8.7 ka.

Nina Lake (No. 12), the most northerly site in B-B^1 transect, does not exhibit evidence of the pollen anomaly that characterizes the Manitoulin Island sites. By 9.5 ka *Picea* starts to increase and attains peak percentages before being replaced by *Pinus* at 8.7 ka.

Transect C-C^1 runs south-north across the central Great Lakes from Wintergreen Lake in southeast Lake Michigan basin to Upper Mallot Lake in eastern Lake Superior basin. The early part of the Wintergreen Lake record (No. 13) shows an uninterrupted succession from *Picea* to *Pinus* to *Quercus* dominance between 11.4 and 9 ka. Vestaburg Bog (No. 14) in south-central Michigan has the *Picea-Pinus* transition about 10.3 ka. Unlike Wintergreen Lake, *Picea* increases again to a minor peak at Vestaburg Bog after 10.3 ka and *Pinus* decreases proportionally at the same time. Subsequently, *Picea* falls, to be replaced by the return of *Pinus* and increase of *Quercus*. Further north, based on downward extrapolation of rates of sedimentation between 5805 BP (oldest date) and 7620 BP (increase of *Tsuga*) at Lake Sixteen (No. 15), the *Picea* recurrence is estimated at 9.7 to 9.3 ka. Upper Mallot Lake (No. 16) documents a clear *Picea* peak prior to 9 ka, after which *Picea* declines but lingers on to about 8 ka; *Pinus* remains low and increases substantially with the decline in *Picea* shortly after 8 ka.

Transect D-D^1 extends across the western Lake Superior basin from Disterhaft's Farm Bog (No. 17) in the south to Cummins Pond (No. 21) in the north. The Disterhaft Farm site shows an uninterrupted succession from *Picea* to *Pinus* to *Quercus* between 11 and 8.5 ka. Seidel Lake (No. 18) shows the same uninterrupted *Picea-Pinus* succession at about 11 ka followed by an undisputed *Pinus* dominance. However, at approximately 9.7 ka, the *Pinus* dominance was abruptly interrupted by a *Picea* recurrence which dominated to about 9.4 ka. *Pinus* returned to its previous dominance before being replaced by *Quercus* by about 8.5 ka. Wood Lake (No. 19) shows *Picea* decreasing abruptly from dominant values between 10.7 and 10 ka but lingering on into the early Holocene to 7.9 ka. The lingering presence of *Picea* is compensated by a proportional and significant decrease in *Pinus* which becomes dominant when *Picea* finally disappears from the record. More northward in the transect at Lake Mary (No. 20), *Picea* decreases upward from the base but increases to peak values before declining at 9.4 ka, while at the same time, *Pinus* decreases by a proportional amount. Like Wood Lake, *Picea* lingers on within the *Pinus*-dominant period to about 8 ka. Cummins Pond (No. 21), on the northwest shore of Lake Superior, is marked by consistently high *Picea* percentages from the base of the record at 8.1 ka upward to 7 ka. The *Picea* decline at 7 ka is compensated by a gradual increase in *Pinus strobus*.

Transect E-E^1 crosses western Lake Superior region from Kirchner Marsh (No. 22) in the south to Rattle Lake (No. 26) in the north. Kirchner Marsh shows an uninterrupted pollen succession beginning with *Picea*, which gives way to *Pinus*, which gives way to *Quercus* within the timeframe 10 to 9 ka. However, more northward in the transect, *Picea* lingers on well into the period of *Pinus* dominance. The end of the lingering persistence of *Picea* is dated or estimated at 7.8 ka (Jacobson and Rattle lakes), 7.85 ka (Myrtle Lake) and 7.9 ka (Weber Lake).

Anomalies in the Northward Migrating Spruce-Pine Ecotone

Anomalous pollen records are located at sites within and bordering the Great Lakes. The anomalies, which fall into two separate timeframes, 11 - 10 ka and 10 - 7.5 ka, consist of a) a recurrence of *Picea* sometimes accompanied by a lingering persistence of herb pollen, b) a second recurrence of *Picea* within *Pinus*-dominated assemblages, and c) a lingering persistence of *Picea* well into the period of *Pinus* dominance. The anomalies represent re-advances of the spruce front and dominance of spruce over pine in the northward migrating spruce-pine ecotone.

The 11 - 10 ka Anomalies

The return of *Picea* following an interval of deciduous pollen dominance at sites from the Till Plains south of Lake Michigan and western Lake Erie represents the most compelling evidence of the 11 - 10 ka anomaly. Pollen diagrams from the Pyle Site, Indiana, and Bucyrus Bog, Ohio (Shane 1987, 1989) show *Picea* reappearing in these pollen records at 11 ka at the expense of deciduous trees such as *Fraxinus* and *Ostrya/Carpinus* (Figures 8.1 and 8.5). The *Picea* return is interpreted as a climatic reversal, a switch to a cooler climate which favoured spruce but was detrimental to deciduous forest growth (Shane 1987, 1989; Shane and Anderson 1993); *Pinus*, and subsequently *Quercus* increased abruptly following the *Picea* peak implying climatic warming. The *Picea* recurrence is also obvious at other sites on the Till Plains (Figure 8.1), i.e., Stotzel-Leis, Ohio, and Pretty, Clear and Hudson Lakes, Indiana (Shane 1987). Correlative with the *Picea* recurrence anomaly on the Till Plains was an increase in *Abies* (fir) pollen reflecting fir expansion into the spruce forest on the Allegheny Plateau south of Lake Erie (Shane 1987).

Coincident with the 11 - 10 ka *Picea* recurrence in the Till Plains south of the Great Lakes was a decrease of *Picea* dominance, and at the same time, a lingering persistence or increase of herb pollen at certain sites in and bordering the upper Great Lakes. *Picea* decreases and herb pollen increases after 11.2 ka but prior to 10.3 ka at Kincardine Bog (Figure 8.2), just prior to 10.5 ka at Edward Lake (Figure 8.2), and up to the end of Lake Algonquin deposition estimated at 10.5 ka at the M17 and Mackinac Basin sites in Lake Huron (Lewis and Anderson 1989; Zilans 1985). High shrub and herb and corresponding high *Picea* percentages dominate to the end of Lake Algonquin deposition at two sites (P-10 and 17P) in Georgian Bay (McAtee 1977;

Tovell *et al.* 1972). The increase in herb pollen and decrease in *Picea* is a northerly response of the same climatic cooling that triggered the *Picea* resurgence in the more southerly sites.

The 10 - 7.5 ka Anomalies

A *Picea* recurrence within the period of *Pinus* dominance in pollen records from the upper Great Lakes region (Figure 8.2) is the clearest evidence of the 10 - 7.5 ka anomaly. The earliest dates for onset and termination of the *Picea* recurrence are 9.7 and 9.4 ka, respectively, at Strain and Plate lakes (Figure 8.2), in the eastern Georgian Bay area. It occurs shortly after 10 ka and prior to 9 ka at M17 site, Lake Huron, and is dated between 9410 and 7860 BP at the Sheguiandah site, Manitoulin Island. Onset of the recurrence is conventionally dated at 9930 BP at Greenbush Swamp (Warner *et al.* 1984), but based on the more precise AMS dates at nearby Sheguiandah, the 9930 BP date is considered too old by as much as 500 years (Anderson, this volume). Other sites where the spruce recurrence is dated or estimated include Lake Sixteen (9.7 - 9.3 ka), Seidel Lake (9.7 - 9.4 ka), Vestaburg Bog (shortly after 10.3 ka), and Lake Mary (prior to 9.4 ka) (Figure 8.2). The widespread occurrence of high but declining percentages of *Picea* persisting well into the period of *Pinus* dominance (Figure 8.2) is another 10 - 7.5 ka anomaly common to the upper Great Lakes region. The lingering persistence of *Picea* is always accompanied by depressed percentages of *Pinus* and often coincides with maxima in *Abies* and *Betula*. Kincardine Bog, Wood Lake, Weber Lake, Myrtle Lake and Cummins Pond provide excellent examples of this anomaly (Figure 8.2). Lingering persistence of *Picea* continues uninterrupted to 7620 BP at Kincardine, to 7935 BP at Wood Lake, to 7930 BP at Weber Lake, to 7850 BP at Myrtle Lake, to as late as 7000 BP at Cummins Pond.

Discussion

The pollen anomalies represent climate-induced changes which can be explained by changes in North American air-mass distribution (Yu and Eicher 1989; Yu 2000; Hu *et al.* 1999) or lake effect (Lewis and Anderson 1989, 1992), or from a combination of both. Both were abrupt short-term events, the lake effect being locally restricted to terrestrial areas adjacent to the Great Lakes, whereas the changing air-mass distributions were more regional in extent.

Sites characterized by the 11 - 10 ka pollen anomaly were located within or bordered glacial Main Lake Algonquin which had occupied Georgian Bay, Lakes Huron and Michigan and extreme southeastern Lake Superior basins 11 to 10.5 ka (Lewis and Anderson 1989). This large-area, high-level lake was likely kept cold well into the growing season by the summer presence of melting icebergs and eastward runoff from glacial Lake Agassiz (Anderson and Lewis 1992). The cold water surface, acting much like a heat sink, cooled the overlying air masses. Westerlies crossing the cold lake surfaces would have been dominated by cold onshore winds which cooled the adjoining lakeshores and downwind-land areas. The result of the lake effect would have been a delay in the onset of seasonal warming in terrestrial areas bordering the lake favouring spruce growth at the expense of hardwoods, and tundra-like conditions at the expense of spruce, in the more southerly and northerly areas, respectively, bordering Lake Algonquin. The end of the cold interval coincided with a reduction of the large-area glacial lake phase when Main Lake Algonquin drained to the North Atlantic Ocean via the Ottawa-St. Lawrence lowland about 10.5 ka.

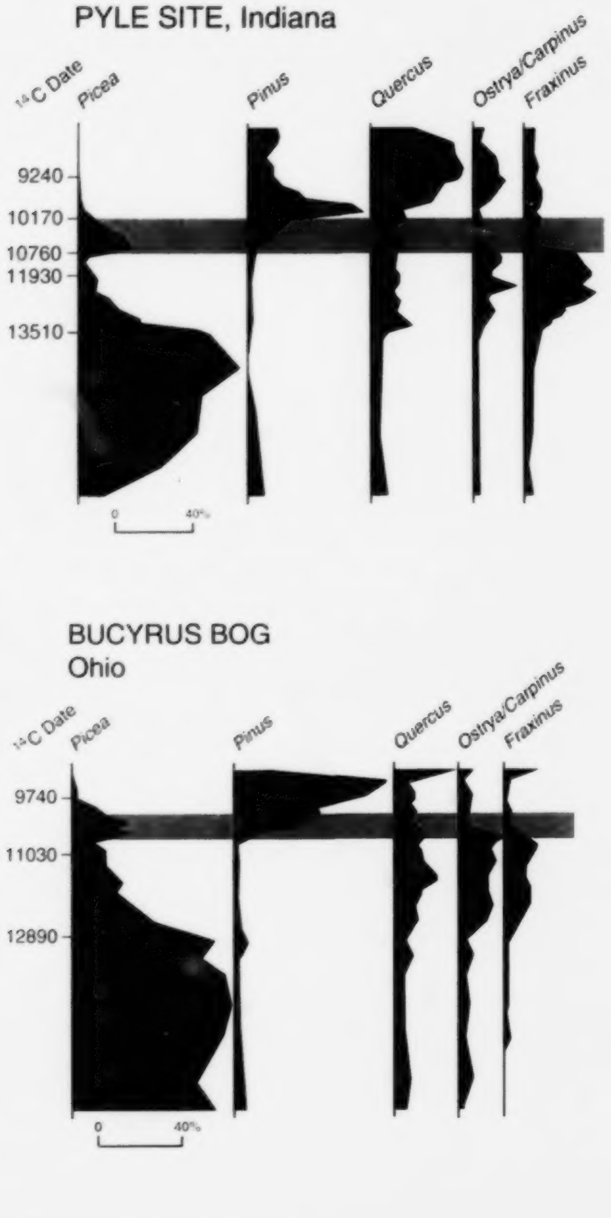


Figure 8.5. Abbreviated pollen diagrams from the Pyle site, Indiana and Bucyrus Bog, Ohio (modified from Shane 1987, 1989).

Alternatively, the 11 - 10 ka cool episode may be tied to the North Atlantic Younger Dryas (YD) cold period and attributed to it perhaps in combination with a lake effect. Based on evidence from the Till Plains south of Lakes Michigan and Erie, Shane (1987) and Shane and Anderson (1993) showed a deciduous forest was interrupted by a return to spruce dominance at 11-10 ka and suggested that the spruce recurrence occurred in response to the Younger Dryas cooling. Supporting evidence is also present at sites inland away from the high level lakes in southern Ontario. Recently Yu and Eicher (1998) and Yu (2000) presented convincing evidence that abrupt late glacial changes in two lakes from southern Ontario similarly can be tied to the Younger Dryas event. Their evidence consists of stable isotopes and other proxy data which are comparable with similar records in Greenland. These two occurrences of Younger Dryas-induced climate change (and others reviewed by Yu and Wright (2001)) suggest the Younger Dryas cold event may have exerted a far greater influence in inland eastern North America than previously assessed by the use of GISS general circulation models (Rind *et al.* 1986) or recognized previously by us (Anderson and Lewis 1992).

Figure 8.6 shows the fluctuating spruce front and spruce-pine ecotone in the Great Lakes region between 13 and 7.5 ka. Deglacial warming allowed hardwoods to migrate into and dominate the Till Plains of Ohio and Indiana north to southernmost Michigan and Ontario from 13 to about 11.2 ka. Climatic conditions remained stable within this interval, but at 11 ka, the climate abruptly started to cool. The vegetative response to the cooler climate was a southward re-advance of spruce into the Till Plains reaching its maximum limit about 10.8 ka (Figures 8.6, 8.7). At the same time, fir expanded on the Allegheny Plateau (Shane 1987; Shane and Anderson 1993) and tundra vegetation expanded at the expense of spruce in terrestrial areas of the upper Great Lakes region, i.e., southern Lake Huron and southeastern Georgian Bay.

Drainage of Main Lake Algonquin and post-Younger Dryas regional warming allowed pine to advance northward into the Great Lakes region replacing spruce in the Till Plains of Ohio and Indiana and the Erie-Michigan lowlands and spruce and herbs in the upper Great Lakes region. By 10 ka, the spruce-pine ecotone stood in southern Ontario and extended across southern Michigan and southern Lake Michigan where it deflected northward into central Wisconsin (Figure 8.7). By 9.75 ka, pine had advanced further northward into the southern Georgian Bay and Lake Huron basins, to northern Lake Michigan and the northern peninsula of Michigan to northern Wisconsin.

Cooling between 9.7 and 9.4 ka, however, allowed spruce to dominate the ecotone again and re-advance southward into central Wisconsin, south-central Michigan and southeast Georgian Bay area to the position marked by the 9.65 ka isochrone (Figure 8.7). The 9.7 - 9.4 ka cooling is correlated with the North Atlantic Pre-boreal Oscillation (PB) (Yu and Eicher 1989; Yu 2000). Yu (2000) has recognized a similar PB event at Twiss Marl Lake, southern Ontario, based on abrupt changes in oxygen isotopes, Chara-encrustations, pollen and plant macrofossils, and bulk carbonates which he has dated at 9650 BP. However, the Twiss Marl Lake pollen evidence for this cooling is subtle and inconclusive as it lacks the spruce recurrence that is characteristic of the upper Great Lakes sites suggesting this site was outside (south) of the spruce-pine ecotone. Continued northward advance of regional warming in the eastern, south-central and southwestern extremities of the Great Lakes region, allowed pine to replace spruce again after 9.4 ka.

The 9.4 - 7.8 ka spruce recurrence at Sheguiandah correlates with events associated with the advancing-retreating Marquette Ice that filled Lake Superior basin (Farrand and Drexler 1985). The Marquette re-advance created the Cartier morainic belt about 10 ka (Saarnisto 1974) based on several dates ranging between 9895 BP to 10,200 BP (Lowell *et al.* 1999). By 9500 BP, it retreated to the position of the Chapleau Moraine on the north side of Lake Superior (Saarnisto 1974). Lake Superior basin was therefore likely ice-free a few centuries earlier or by 9700 - 9800 BP. Opening of Lake Superior probably gave birth to the Post Duluth glacial lakes in the Superior basin and the correlative Early Lake Mattawa in Lake Huron and Georgian Bay when eastward discharge of glacial Lake Agassiz was initiated again.

Bryson and Wendland (1967) surmise that the climate at the top of the Laurentide Ice Sheet, including the Marquette Ice, a Lake Superior lobe of the Laurentide Ice Sheet, probably comprised an anticyclonic (clockwise) circulation which resulted in outbreaks of northern air with low relative humidity in areas bordering the glacier. At the same time, they suggest that strong westerlies (Pacific Air) would have dominated areas south of the glacier terminus in northern Illinois, Indiana, Ohio and Pennsylvania. Edwards *et al.* (1996) suggest this wedge of Pacific Air was operative in the western sector of the upper Great Lakes region as early as 10,000 BP (Figure 8.8a).

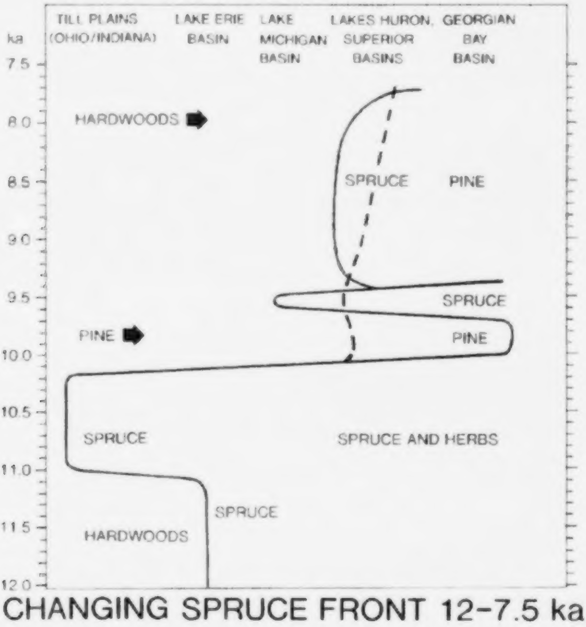
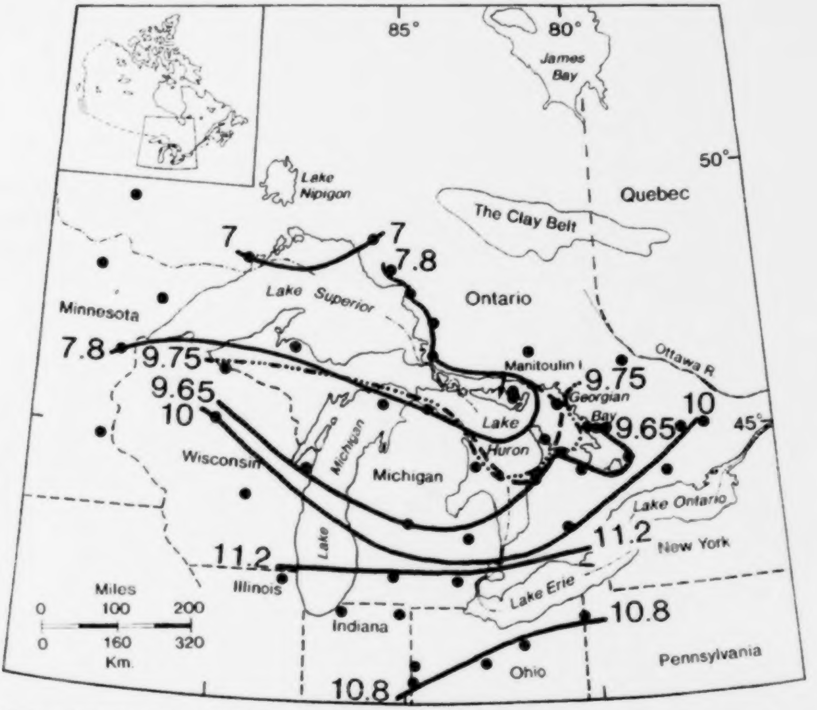

TILL PLAINS (OHIO/INDIANA)
LAKE ERIE BASIN
LAKE MICHIGAN BASIN
LAKES HURON, SUPERIOR BASINS
GEORGIAN BAY BASIN
ka
7.5
8.0
8.5
9.0
9.5
10.0
10.5
11.0
11.5
12.0
HARDWOODS
SPRUCE
PINE
SPRUCE
PINE
PINE
SPRUCE
SPRUCE AND HERBS
SPRUCE
HARDWOODS
CHANGING SPRUCE FRONT 12-7.5 ka

Figure 8.6. Time-distance diagram showing the fluctuating spruce front and spruce-pine ecotone in the Great Lakes region at 13 - 7.5 ka. Sites in the Lake Huron and Lake Superior basins show readvances of spruce at 9.7 to 9.4 ka and 9.4 to 7.8 ka (solid lines) or a lingering persistence of spruce well into the period of *Pinus* dominance to about 7.8 ka (broken line).


85°
80°
James Bay
50°
45°
Lake Nipigon
Quebec
The Clay Belt
Ontario
Minnesota
Lake Superior
Ottawa R.
Manitoulin I.
Georgian Bay
Lake Huron
Wisconsin
Lake Michigan
Michigan
Lake Ontario
New York
Illinois
Indiana
Lake Erie
Ohio
Pennsylvania
7
7
7.8
7.8
9.75
9.75
9.65
9.65
10
10
11.2
11.2
10.8
10.8
Miles
0
100
200
0
160
320
Km.

SPRUCE-PINE ECOTONE ISOCHRONES (ka)

Figure 8.7. Approximate isochrone positions of the spruce-pine ecotone between 11.2 and 7 ka. Prior to 11 ka (11.2 ka) the spruce-pine ecotone was probably situated on the Till Plains between southern Lake Michigan and Lake Erie. Its southward advance to the Allegheny Plateau at about 10.8 ka coincided with Main Lake Algonquin and the Younger Dryas climatic oscillation; its northward retreat to the 10 ka position coincided with the drainage of Main Lake Algonquin and end of the Younger Dryas cold interval. Post-Algonquin-Younger Dryas warming allowed pine to advance further northward (9.75 ka isochrone) in the eastern, southern, and western extremities of the upper Great Lakes region. The 9.65 ka isochrone (mid point of the 9.7-9.4 ka spruce re-advance) represents cooling of the Preboreal Oscillation. The 7.8 ka isochrone encloses sites characterized by a lingering persistence of spruce to 7.9 and 7.6 ka; the broken 7.8 isochrone accommodates prolonged cooling at Kincardine. The easterly extension of the 7.8 ka isochrone to Manitoulin Island shows the entire upper Great Lakes experienced prolonged cooling well into the middle Holocene. Continued regional warming eventually forced the spruce-pine ecotone north of the Great Lakes indicated by the 7 ka isochrone.

We propose that the dry northern air coupled with the Pacific Air would have created dry conditions in terrestrial areas bordering the ice margin which would have favoured pine expansion at the expense of spruce into the upper Great Lakes region to possibly as late as 9500 BP. With retreat of Marquette Ice out of Lake Superior basin by 9500 BP, the wedge of Pacific Air would have widened as it migrated northward (Edwards *et al.* 1996) (Figure 8.8b) effectively cutting off the northern source of drier air. The onset of the *Picea* recurrence at 9.4 ka at Sheguiandah correlates with moisture advection and downwind cooling induced by the strong westerlies blowing across the newly emerged, cold waters of Lake Superior similar in many respects to the modern-day cooling effects of Hudson Bay (Rouse 1991) or the Robert-Bourassa Reservoir in northern Quebec (Tremblay and Begin 2000) on local terrestrial areas bordering these water bodies. The cooling effect is illustrated by the northwest-southeast lobe of spruce dominance that extended eastward from western Lake Superior to Manitoulin Island (Figure 8.7). It was accompanied by enhanced precipitation judging by the increase in precipitation (by as much as 260 mm per annum) between 9.8 and 8 ka at Upper Mallot Lake (J.H. McAndrews, personal communication, 2001).

The Lake Superior cooling effect, perhaps in combination with southward outbreaks of arctic air masses across the collapsing central ice dome over Hudson Bay about 7900 BP (Hu *et al.* 1999), prolonged cooling well into the period of *Pinus* dominance. These arctic outbreaks impeded effects of the northward advance of regional warming. The 7.8 ka isochrone (Figure 8.7) encompasses sites where the end of prolonged cooling (end of lingering persistence of *Picea*) is dated or estimated at 7.6 to 7.9 ka; its eastern extension to Manitoulin Island shows the prolonged cooling effect was centered over Lake Superior with a downwind presence in the lee areas of northern Lake Huron and Georgian Bay. By 7 ka, the cooling effect was restricted to the northern Lake Superior area shown by the 7 ka isochrone (Figure 8.7).

At first glance, a lake-effect cooling characterized by enhanced precipitation appears inconsistent with the lowered Huron-Georgian Bay lake levels shown in Figure 8.3 at E (the middle-Stanley-Hough lowstand). However, there is no conflict if the atmospheric lake effect was a transfer of water into a relatively local (northern) part of the Huron-Georgian Bay region while elsewhere the larger part of the drainage basin was affected by a dry climate. Within the drainage basin overall, lowered lake levels would be the result of a net reduced water supply and enhanced evaporation. Amelioration of the dry-climate effect appears to be signaled by an increase of hemlock (*Tsuga)* in pollen diagrams throughout the region at about 7.6 ka (McAndrews 1981; Karrow *et al.* 1975). The hemlock increase is synchronous with the rise in Huron-Georgian Bay lake levels (Figure 3 between G and H). Westerly winds blowing across the Huron and Georgian Bay basins at this time may have induced humid-cool conditions in the lee areas of these lakes thereby providing a suitable growth environment and stimulus for hemlock expansion to the west and northwest and eventually into the upper Great Lakes region (Anderson 1995).

The replacement of spruce by pine and the *Pinus* dominance of the ecotone after 7.8 ka, implies regional warming finally dominated over lake effect everywhere throughout the upper Great Lakes region at this time. The onset of regional warming is reflected by the shift towards mid-Holocene thermal maxima temperatures in northern Ontario (McAndrews 1981) and correlates with the final drainage of glacial lakes Agassiz and Ojibway in northern Ontario to Hudson Bay (Barber *et al.* 1999).

Implications of the Lake-Level History and Climatic Deductions for Humans

The relation of the Sheguiandah archeological site (specifically the nearby swamps and bogs) to lake levels is evident by projecting the trend of the uplift curve shown for the three Sheguiandah dates across the age range of water-level change in Figure 8.3. It is clear the site was inundated by the Main Algonquin highstand until about 11,800 cal BP (about 10.2 ka), then again by the relatively short-lived early Mattawa episode of high lake level. This phase after D (Figure 8.3), presumably eroded any previous deposition of organic sediment from the site about 10,800 cal BP (about 9.5 ka). Although the Main Mattawa highstand rose close to the Sheguiandah site, it did not inundate it. Thus the site was apparently accessible to humans in the post-Algonquin period after about 11,800 cal BP (about 10.2 ka), then continuously after the short-lived early Mattawa inundation since 10,750 cal BP (9.5 ka) approximately. Based on evidence for post-Algonquin-Younger Dryas warming (northward retreat of the spruce-pine ecotone) shortly after 11,800 cal BP (10.2 ka), the 11,800 – 10,600 cal BP (10.2 - 9.4 ka) interval, except for a short period of lake inundation, may have been optimum for early Holocene occupation at Sheguiandah as the climate clearly deteriorated after 10,600 cal BP (9.4 ka) and remained cool to as late as 8800 cal BP (7.8 ka) (Figure 9). In spite of the cooler climate, another potential window for occupation might have been between 10,200 and 9600 cal BP (9 - 8.5 ka) when lake levels were closest to the site for the longest time in the early Holocene (Figure 8.9). The elevation of the site above local Georgian Bay lake level would have varied considerably from less than 10 m during the Mattawa highstand (itself variable) up to about 80 m in the ensuing late Stanley-Hough lowstand. At this low level, Sheguiandah and Manitowaning Bays, which the site presently overlooks, would have been drained and the Sheguiandah archeological site would have been about 20 km inland from the nearest Georgian Bay shore. The site (bog) remained emergent during the subsequent Nipissing transgression and would have been about 21 m above the Nipissing Great Lakes phase.

Substantial expansions and contractions in land connections to Manitoulin Island are also evident in the plot of lake level where lake levels are inferred below the elevations of the Huron basin sills (Figure 8.3). A land bridge between Bruce Peninsula and Manitoulin Island would have been open when the water surface in Georgian Bay fell below the Huron sills. This occurred possibly during the early Stanley-Hough lowstand when lake level in the Georgian Bay basin could have fallen below the Huron sills for periods up to one or two centuries, then again during the mid-Stanley lowstand for up to three centuries perhaps. During the late Stanley lowstand this land bridge may have been open for about 500 years (8900 - 8400 cal BP, 8 - 7.6 ka). It is interesting to note that for at least the middle and late Stanley-Hough phases (E and G), the lake-level plot indicates these lowstands were hydrologically closed lakes, their levels well below the basin outlet sills. Closed-lake status implies that the pollen-inferred warm regional climate was substantially drier than today with a negative water balance in which surface evaporation drew the lake levels down to decrease their surface area until the evaporative losses could be balanced by precipitation and runoff. This new finding is consistent with the recognition of the Flowerpot paleo-beach now 52 m below the surface of Georgian Bay (Blasco 2001; Blasco *et al.* 2001), and with similar evidence of early to middle Holocene lake levels lower than the outlet sill in the Erie basin (Lewis 1999; Lewis *et al.* 1999). It is also compatible with the recent discovery that southern Lake Winnipeg, west of the Superior basin, had dried up during the early and middle Holocene (Lewis *et al.* 2000, 2001).

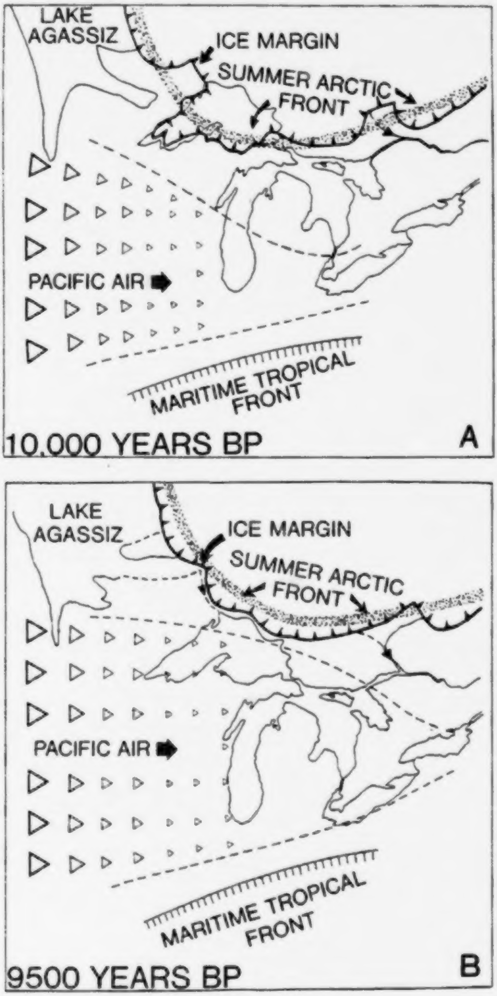

LAKE AGASSIZ
ICE MARGIN
SUMMER ARCTIC FRONT
PACIFIC AIR
MARITIME TROPICAL FRONT
10,000 YEARS BP
A
LAKE AGASSIZ
ICE MARGIN
SUMMER ARCTIC FRONT
PACIFIC AIR
MARITIME TROPICAL FRONT
9500 YEARS BP
B

Figure 8.8. Models of air mass circulation over the upper Great Lakes at 10,000 BP and 9500 BP (from Bryson and Wendland 1967; Edwards *et al.* 1996). A) At 10,000 BP, Marquette Ice, a Lake Superior lobe of the Laurentide Ice Sheet, filled Lake Superior basin. Also shown is the extent of glacial Lake Agassiz and the approximate frontal positions of three intersecting air masses, Arctic (Laurentide Ice) front from the north, Tropical front from the south, and Pacific Air from the west. B) By 9500 BP, Marquette Ice had retreated out of Lake Superior basin; Lake Agassiz retreated further northward and the Laurentide Ice margin stood north of the Great Lakes. The wedge of Pacific Air would have widened as it also migrated further northward.

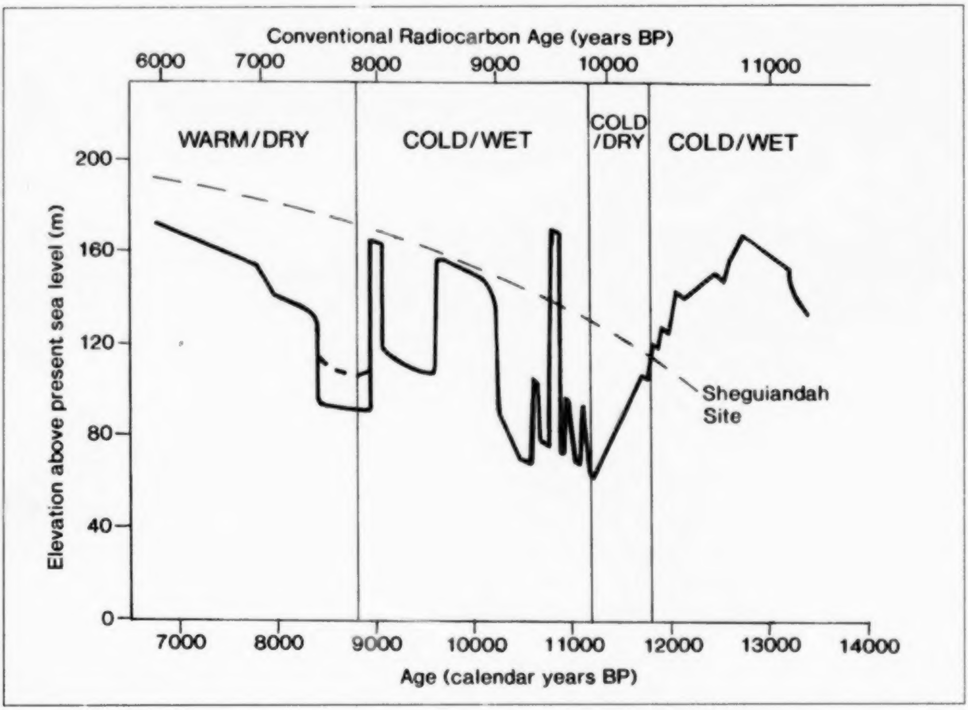


Figure 8.9. Summary diagram showing the relationship between climate and lake-level history for the Lake Huron and Georgian Bay basins 13,400 - 6700 cal BP (11.4 - 6.1 ka). The thick solid line is the lake level interpretation (Figure 8.3). Dashed line (through Sheguiandah 9, 9b and 9c) represents the uplift history for the Sheguiandah site.

Some Considerations for Future Improvement of the Lake History Model and Chronology of Events

Presentation of lake history on the calibrated calendar time scale has revealed a surprising expansion of the 9.4 - 10.6 ka period which was previously compressed by the non-linear radiocarbon age scale. Awareness of this effect is potentially important for the correlation of events and consideration of processes and events during the drainage of Lake Algonquin and formation of the post-Algonquin shorelines.

A priority for future research is to improve the chronology, correlation, and understanding of the processes which produced the Main Algonquin and Nipissing shore datums in the upper Great Lakes.

The terrains of Manitoulin Island and other areas in the northern Lake Huron-Georgian Bay basin carry a rich geomorphic record of former lake shorelines, but little if any hard data exists on the age of these features. Considerable advance in understanding the overall lake history can be anticipated with future serious efforts to improve spatial correlations and age determinations of shoreline indicators of the post-Algonquin and Mattawa lake phases. The same comment holds for underwater investigations which can be expected to yield critical data on the extent, elevation, and paleo-environments of lowstands and landbridges in lake history.

The possibility of the existence of hydrologically closed lakes (lake level below outlet sill) is a new development, but one of extreme significance for understanding changes in climate, hydrology, biogeography and human habitat during the postglacial evolution of the Great Lakes. Confirming studies are urgently needed to test this hypothesis.

The AMS dates obtained at the Sheguiandah archeological site have refined the age limits of the early Holocene climate reversal (*Picea* recurrence) in the upper Great Lakes region. More AMS dating of this and other upper Great Lakes Holocene climate events is recommended at other lake sites in the area to test the reliability of known conventional dates which may be subject to an unknown offset by the hardwater effect.

Acknowledgements

T. Barry, Geological Survey of Canada, computer drafted the pollen diagrams. Figure 8.3 was computer generated by R. Lacroix, GSC, Ottawa, Ont. and Ken Hale, GSC, Dartmouth, N.S. J. H. McAndrews (University of Toronto) kindly provided unpublished precipitation data for three lake sites.

References

Anderson, T.W. 1978. South Bay, Manitoulin Island, a preliminary report. In *Geology of the Manitoulin Area*, edited by J.T. Sanford and R.E. Mosher, p. 93. Michigan Basin Geological Society, Special Paper 3.

Anderson, T.W. 1995. Forest changes in the Great Lakes region at 5-7 ka BP. *Géographie physique et Quaternaire* 49: 99-116.

Anderson, T.W. and C.F.M. Lewis. 1992. Climatic influences of deglacial drainage changes in southern Canada at 10 to 8 ka suggested by pollen evidence. *Géographie physique et Quaternaire* 46: 255-272.

Anderson, T.W., C.F.M. Lewis and R.J. Mott. 2001. AMS-revised radiocarbon ages at Turtle Lake, North Bay-Mattawa area, Ontario: implications for the deglacial history of the Great Lakes region. *Program and Abstracts*, Canadian Geophysical Union, 27th Annual Scientific Meeting, May 14-17, Ottawa, Ontario.

Bailey, R.E. 1972. *Late- and postglacial environmental change in northwestern Indiana*. Ph.D. thesis, Indiana University, Bloomington.

Bailey, R.E. and P.J. Ahearn. 1981. A late and postglacial pollen record from Chippewa Bog, Lepeer Co., MI.: Further examination of white pine and beech immigration into the central Great Lakes region. In *Geobotany II*, edited by R.C. Romans, pp. 53-74. New York: Plenum Press.

Barber, D.C., A. Dyke, C. Hillaire-Marcel, A.E. Jennings, J.T. Andrews, M.W. Kerwin, G. Bilodeau, R. McNeely, J. Southon, M.D. Morehead and J.-M. Gagnon. 1999. Forcing of the cold event of 8,200 years ago by catastrophic drainage of Laurentide lakes. *Nature* 400: 344-348.

Barnett, P.J. 1992. Quaternary geology of Ontario. In *Geology of Ontario*, edited by P.C. Thurston, H.R. Williams, R.H. Sutcliffe, and G.M. Scott, pp. 1011-1088. Ontario Geological Survey, Special Volume 4, Part 2.

Bender, M., R.A. Bryson and D.A. Baerreis. 1971. University of Wisconsin Radiocarbon Dates IX. *Radiocarbon*, 13: 475-486.

Bennett, K.D. 1987. Holocene history of forest trees in southern Ontario. *Canadian Journal of Botany* 65: 1792-1801.

Bjorck, F. 1985. Deglaciation and revegetation in northwest Ontario. *Canadian Journal of Earth Sciences* 22: 850-871.

Blasco, S.M. 2001. Geological history of Fathom Five National Marine Park over the past 15000 years. In *Ecology, Culture and Conservation of a Protected Area: Fathom Five National Marine Park, Canada*, edited by S. Parker and M. Munawar, pp. 45-62. Leiden, The Netherlands: Brackhuys Publishers, Ecovision Monograph Series.

Blasco, S.M., S.E. Janusas, S. McClellan and A. Amos. 1997. Prehistoric drainage across the submerged Niagara Escarpment north of Tobermory. *Leading Edge '97, Niagara Escarpment and Long Point*, Conference Proceedings, October 16-18, 1997, Burlington, Ontario, pp. 218-225.

Blasco, S.M., C.F.M. Lewis, F. McCarthy and A. Sarvis. 2001. Evidence for climate-driven low lake levels in the Georgian Bay basin at 7600 BP. *Program and Abstracts*, International Association for Great Lakes Research, 44th Conference on Great Lakes Research, June 2001, Green Bay, WI., pp. 6-7.

Bostock, H.S. 1970. Physiographic subdivisions of Canada. In *Geology and Economic Minerals of Canada*, edited by R.J.W. Douglas, pp. 10-30. Geological Survey of Canada, Economic Geology Report No.1.

Brown, D.M., G.A. McKay and L.J. Chapman. 1968. *The climate of southern Ontario*. Climatological Studies No. 5, Department of Transport.

Bryson, R.A. and W.M. Wendland. 1967. Tentative climatic patterns for some late glacial and post-glacial episodes in central North America. In *Life, Land and Water*, edited by W.J. Mayer-Oakes, pp. 271-297. Winnipeg: University of Manitoba Press.

Chapman, L.J. 1954. An outlet of Lake Algonquin at Fossmill, Ontario. *Geological Association of Canada Proceedings* 6: 61-68.

Chapman, L.J. 1975. The physiography of the Georgian Bay-Ottawa Valley area of southern Ontario. *Ontario Division of Mines, Geoscience Report* 128, 33 pp.

Chapman, L.J. and D.F. Putnam. 1984. *The Physiography of Southern Ontario*. Toronto: Ontario Ministry of Natural Resources, Ontario Geological Survey, Special Volume 2, 270 p.

Chittenden, R. 1990. *The origin of Wye marsh*. Midland, Ontario: A publication of Wye Marsh Wildlife Centre, 50 p.

Cowan, W.R. 1985. Deglacial shorelines at Sault Ste. Marie. In *Quaternary Evolution of the Great Lakes*, edited by P.F. Karrow and P.E. Calkin, pp. 33-37. Geological Association of Canada, Special Paper, 30.

Cushing, E.J. 1967. Late-Wisconsin pollen stratigraphy and the glacial sequence in Minnesota. In *Quaternary Paleoecology*, edited by E.J. Cushing and H.E. Wright, Jr., pp. 59-88. New Haven: Yale University Press.

Davis, M.B. 1981. Outbreaks of forest pathogens in Quaternary history. *Proceedings IVth International Palynological Conference* 3: 216-227.

Deane, R.E. 1950. Pleistocene geology of the Lake Simcoe district, Ontario. *Geological Survey of Canada Memoir* 256 108 pp.

Dyke, A.S. 1996. Preliminary paleogeographic maps of glaciated North America. *Geological Survey of Canada*, Open File 3296.

Dyke, A.S. and V.K. Prest. 1987. Late Wisconsinan and Holocene history of the Laurentide ice sheet. *Géographie physique et Quaternaire* 41: 237-263.

Edwards, T.W.D. and J.H. McAndrews. 1989. Paleohydrology of a Canadian Shield lake inferred from ^{18}O in sediment cellulose. *Canadian Journal of Earth Sciences* 26: 1850-1859.

Edwards, T.W.D., B.B. Wolfe and G.M. MacDonald. 1996. Influence of changing atmospheric circulation on precipitation δ^{18}O-temperature relations in Canada during the Holocene. *Quaternary Research* 46: 211-218.

Eschman, D.F. and P.F. Karrow. 1985. Huron basin glacial lakes: a review. In *Quaternary Evolution of the Great Lakes*, edited by P.F. Karrow and P.E. Calkin, pp. 79-93. Geological Association of Canada, Special Paper 30.

Farrand, W.R. 1960. Former shorelines in western and northern Lake Superior. Ph.D. dissertation, University of Michigan, 266 pp.

Farrand, W.R. and C.W. Drexler. 1985. Late Wisconsinan and Holocene history of the Lake Superior basin. In *Quaternary Evolution of the Great Lakes*, edited by P.F. Karrow and P.E.Calkin, pp. 17-32. Geological Association of Canada, Special Paper 30.

Finamore, P.F. 1985. Glacial Lake Algonquin and the Fenelon Falls outlet. In *Quaternary Evolution of the Great Lakes*, edited by P.F. Karrow and P.E. Calkin, pp. 125-132. Geological Association of Canada, Special Paper 30.

Ford, M.J. and R.S. Geddes. 1986. *Quaternary geology of the Algonquin Park area*. Ontario Geological Survey Open File Report 5600, 87 pp.

Fries, M. 1962. Pollen profiles of late Pleistocene and recent sediments from Weber Lake, Minnesota. *Ecology* 43: 295-308.

Futyma, R.P. 1981. The northern limits of Lake Algonquin in Upper Michigan. *Quaternary Researc* 291-310.

Futyma, R.P. and N.G. Miller. 1986. Stratigraphy and genesis of the Lake Sixteen peatland, norther Michigan. *Canadian Journal of Botany* 64: 3008-3019.

Gareau, P., C.F.M. Lewis, A. Sherin, R. Macnab, T.C. Moore, Jr., D.R. Rea, L.C.K. Shane and A.J. Smith. 2001. *Digital reconstruction of the areas, volumes and geography of the paleo-Great La (after 11.5 ka)*. Geological Survey of Canada, Open file Report, Ottawa, in press.

Gilliam, J.A., R.O. Kapp and R.D. Bogue. 1967. A post-Wisconsin pollen sequence from Vestaburg Montcalm County, Michigan. *Papers of the Michigan Academy of Science, Arts, and Letters* 52 17.

Goldthwait, J.W. 1908. A reconstruction of water planes of the extinct glacial lakes in the Lake Mich basin. *Journal of Geology* 16: 459-476.

Goldthwait, J.W. 1910. *An instrumental survey of the shorelines of extinct lakes in southwestern Ont* Geological Survey of Canada Memoir 10, 57 pp.

Harrison, J.E. 1970. Deglaciation and proglacial drainage: North Bay-Mattawa region, Ontario. *Proceedings 13th Conference on Great Lakes Research, International Association of Great Lak Research*, Buffalo, New York, pp. 756-767.

Harrison, J.E. 1972. Quaternary geology of the North Bay-Mattawa region. *Geological Survey of Ca* Paper 71-26: 1-37.

Heide, K. 1984. Holocene pollen stratigraphy from a lake and small hollow in north-central Wiscons USA. *Palynology* 8: 3-20.

Hough, J.L. 1955. Lake Chippewa, a low stage of Lake Michigan indicated by bottom sediments. *Geological Society of America Bulletin* 66: 957-968.

Hough, J.L. 1958. *Geology of the Great Lakes*. Urbana, Illinois: University of Illinois Press, 313 p.

Hough, J.L. 1962. Lake Stanley, a low stage of Lake Huron indicated by bottom sediments. *Geologi Society of America Bulletin* 73: 613-620.

Hu, F.S., D. Lawinski, H.E. Wright, Jr., E. Ito, R.G. Johnson, K.R. Kelts, R.F. McEwan and A. Boedigheimer. 1999. Abrupt changes in North American climate during early Holocene times. *Nature* 400: 437-440.

Janssen, C.R., 1968. Myrtle Lake: a late- and post-glacial pollen diagram from northern Minnesota. *Canadian Journal of Botany* 46: 1397-1408.

Johnson, M.D., D.K. Armstrong, B.V. Sanford, P.G. Telford and M.A. Rutka. 1992. Paleozoic and Mesozoic geology of Ontario. In *Geology of Ontario*, edited by P.C. Thurston, H.R. Williams, Sutcliffe, and G.M. Scott, pp. 907-1008. Ontario Geological Survey, Special Volume 4, Part 2.

Julig, P.J., J.H. McAndrews and W.C. Mahaney. 1990. Geoarchaeology of the Cummins site on the of proglacial Lake Minong, Lake Superior basin, Canada. In *Archaeological Geology of North*

America, edited by N.P. Lasca and J. Donahue, pp. 21-50. Boulder, Colorado: Geological Society of America, Centennial Special Paper 4.

Karrow, P.F. 1980. The Nipissing transgression around southern Lake Huron. *Canadian Journal of Earth Sciences* 17: 1271-1274.

Karrow, P.F. 1986. Valley terraces and Huron basin water levels, southwestern Ontario. *Geological Society of America Bulletin* 97: 1089-1097.

Karrow, P.F. 1987. Glacial and glaciolacustrine events in northwestern Lake Huron, Michigan and Ontario. *Geological Society of America Bulletin* 98: 113-120.

Karrow, P.F., T.W. Anderson, A.H. Clarke, L.D. Delorme and M.R. Sreenivasa. 1975. Stratigraphy, paleontology and age of Lake Algonquin sediments in southwestern Ontario, Canada. *Quaternary Research* 5: 49-87.

Kaszycki, C.A. 1985. History of glacial Lake Algonquin in the Haliburton region, south central Ontario. In *Quaternary Evolution of the Great Lakes*, edited by P.F. Karrow and P.E. Calkin, pp. 109-123. Geological Association of Canada, Special Paper 30.

King, J.E. 1981. Late Quaternary vegetational history of Illinois. *Ecological Monographs* 51: 43-62.

Kor, P.S.G., J. Shaw, D.R. Sharpe. 1991. Erosion of bedrock by subglacial meltwater, Georgian Bay: a regional review. *Canadian Journal of Earth Sciences* 28: 623-642.

Larsen, C.E. 1987. *Geological history of glacial Lake Algonquin and the upper Great Lakes*. United States Geological Survey Bulletin 1801, 36 pp.

Larsen, C.E. 1994. Beach ridges as monitors of isostatic uplift in the upper Great Lakes. *Journal of Great Lakes Research* 20: 108-134.

Lee, R.E. 1986. Geology of the Sheguiandah Early Man Site: key concepts and issues. *Geographie physique et Quaternaire* 40: 325-330.

Lee, T.E. 1957. The antiquity of the Sheguiandah site. *The Canadian Field-Naturalist* 71: 117-147.

Leverett, F. and F.B. Taylor. 1915. *The Pleistocene of Indiana and Michigan and the History of the Great Lakes*. United States Geological Survey Monograph 53, 529 p.

Lewis, C.F.M. 1969. Late Quaternary history of lake levels in the Huron and Erie basins. *Proceedings, 12th Conference of Great Lakes Research, International Association of Great Lakes Research*, pp. 250-270.

Lewis, C.F.M. 1970. Recent uplift of Manitoulin Island, Ontario. *Canadian Journal of Earth Sciences* 7: 665-675.

Lewis, C.F.M. 1999. Holocene lake levels and climate, Lakes Winnipeg, Erie and Ontario. In *Proceedings of the Great Lakes Paleo-Levels Workshop: The Last 4000 Years. NOAA Technical Memorandum ERL GLERL-113*, edited by C.E. Sellinger and F.H. Quinn, , pp. 6-19. (available at www.glerl.noaa.gov).

Lewis, C.F.M. and T.W. Anderson. 1989. Oscillations of levels and cool phases of the Laurentian Great Lakes caused by inflows from glacial Lakes Agassiz and Barlow-Ojibway. *Journal of Paleolimnology* 2: 99-146.

Lewis, C.F.M. and T.W. Anderson. 1992. Stable isotope (O and C) and pollen trends in Lake Erie, evidence for a locally-induced climatic reversal of Younger Dryas age in the Great Lakes basin. *Climate Dynamics* 6: 241-250.

Lewis, C.F.M., T.C. Moore, Jr., D.K. Rea, D.L. Dettman, A.M. Smith and L.A. Mayer. 1994. Lakes of the Huron basin: their record of runoff from the Laurentide Ice Sheet. *Quaternary Science Reviews* 13: 891-922.

Lewis, C.F.M., T.W. Anderson, S.M. Blasco, G.D.M. Cameron and J.C. Coakley. 1999. Did early Holocene Lake Erie experience closed-basin conditions? *Program and Abstracts*, 42nd Conference o Great Lakes Research, International Association for Great Lakes Research, May 24-28, 1999, Cleveland, Ohio, A-70.

Lewis, C.F.M., B.J. Todd, D.L. Forbes, E. Nielsen and L.H. Thorleifson. 2000. Architecture, age and lithology of sediments in Lake Winnipeg: seismostratigraphy, long-core lithostratigraphy, and basin evolution. In *1996 Lake Winnipeg Project: cruise report and scientific results*, edited by B.J. Todd, C.F.M. Lewis, D.L. Forbes, L.H. Thorleifson and E. Nielsen, pp. 127-188. Geological Survey of Canada, Open File 3470.

Lewis, C.F.M., D.L. Forbes, B.J. Todd, E. Nielsen, L.H. Thorleifson, P.J. Henderson, I. McMartin, T.W. Anderson, R.N. Betcher, W.M. Buhay, S.M. Burbidge, C.J. Schröder-Adams, J.W. King. K. Moran, C. Gibson, C.A. Jarrett, H.J. Kling, W.L. Lockhart, W.M. Last, G.L.D. Matile, J. Risberg, C.G. Rodrigues, A. Telka and R.E. Vance. 2001. Uplift-driven expansion delayed by middle Holocene desiccation in Lake Winnipeg, Manitoba, Canada. *Geology* 29: 743-746.

Liu, K.B. 1990. Holocene paleoecology of the Boreal Forest and Great Lakes-St. Lawrence Forest in Northern Ontario. *Ecological Monographs* 60: 179-212.

Lowell, T.V., G.J. Larson, J.D. Hughes and G.H. Denton. 1999. Age verification of the Lake Gribben forest bed and the Younger Dryas advance of the Laurentide Ice Sheet. *Canadian Journal of Earth Sciences* 36: 383-393.

Manny, B.A., R.G. Wetzel and R.E. Bailey. 1978. Paleolimnological sedimentation of organic carbon, nitrogen, phosphorus, fossil pigments, pollen, and diatoms in a hypereutrophic, hardwater lake: A case history of eutrophication. *Polskie Archiwum Hydrobiologii* 25: 243-267.

McAndrews, J.H., 1981. Late Quaternary climate of Ontario: temperature trends from the fossil pollen record. In *Quaternary Paleoclimate*, edited by W.C. Mahaney, pp. 319-333. Norwich, England: Geo Abstracts Ltd.

McAndrews, J.H. 1984. Late Quaternary vegetation history of Rice Lake, Ontario, and the McIntyre archaeological site. In *The McIntyre Site: Archaeology, Subsistence and Environment*, edited by R.B Johnston. Ottawa: National Museum of Man, Archaeological Survey of Canada, Mercury Series Paper No. 126.

McAndrews, J.H. and I.D. Campbell. 1993. 6 ka mean July temperatures in eastern Canada from Bartlein and Webb's (1985) pollen transfer functions: Comments and illustrations. In *Proxy Climate Data* *and Models of the Six Thousand Years Before Present Time Interval: the Canadian perspective*, compiled by A. Telka, pp. 22-25. Ottawa: The Royal Society of Canada, Canadian Global Change Program Incidental Report Series No. IR93-3.

McAtee, C.L., 1977. *Palynology of late-glacial and postglacial sediments in Georgian Bay, Ontario, Canada, as related to the Great Lakes history*. M.Sc. thesis, Brock University, 153 p.

McIntyre, S.H., H.C. Duthie and B.G. Warner. 1991. Postglacial development of a marl and peat complex on the Precambrian Shield of north-western Ontario. *Journal of Paleolimnology* 6: 141-155.

Moore, T.C., Jr., D.K. Rea, L.A. Mayer, C.F.M. Lewis and D.M. Dobson. 1994. Seismic stratigraphy of Lake Huron — Georgian Bay and postglacial lake level history. *Canadian Journal of Earth Science* 31: 1606-1617.

Moore, T.C., Jr., J.C.G. Walker, D.K. Rea, C.F.M. Lewis, L.C.K. Shane and A.J. Smith. 2000. Younger Dryas interval and outflow from the Laurentide ice sheet. *Paleoceanography* 1: 4-18.

Morton, J.K. and J.M. Venn. 1984. *The flora of Manitoulin Island and the adjacent islands of Lake Huron, Georgian Bay and the North Channel*. Department of Biology, University of Waterloo, Waterloo, Ontario.

Mott, R.J. and L.D. Farley-Gill. 1978. A late-Quaternary pollen profile from Woodstock, Ontario. *Canadian Journal of Earth Sciences* 15: 1101-1111.

Peltier, W.R. 1994. Ice age paleotopography. *Science* 265: 195-201.

Phillips, D.W. and J.A.W. McCulloch. 1972. *The Climate of the Great Lakes Basin*. Environment Canada, Climatological Studies 20, 50 p.

Prest, V.K. 1970. Quaternary geology of Canada. In *Geology and Economic Minerals of Canada*, edited by R.J.W. Douglas, pp. 675-764. Geological Survey of Canada, Economic Geology Report 1.

Rea, D.K., T.C. Moore, Jr., T.W. Anderson, C.F.M. Lewis, D.M. Dobson, D.L. Dettman, A.J. Smith and L.A. Mayer. 1994a. Great Lakes paleohydrology: Complex interplay of glacial meltwater, lake levels, and sill depths. *Geology* 22: 1059-1062.

Rea, D.K., T.C. Moore, Jr., C.F.M. Lewis, L.A. Mayer, D.L. Dettman, A.J. Smith and D.M. Dobson. 1994b. Stratigraphy and paleolimnologic record of lower Holocene sediments in northern Lake Huron and Georgian Bay. *Canadian Journal of Earth Sciences* 31: 1586-1605.

Rind, D., D. Peteet, W. Broecker and W. Ruddiman. 1986. The impact of cold North Atlantic sea surface temperatures on climate: implications for the Younger Dryas cooling (11-10 k). *Climate Dynamics* 1: 3-33.

Rouse, W.R. 1991. Impacts of Hudson Bay on the terrestrial climate of the Hudson Bay Lowlands. *Arctic and Alpine Research* 23: 24-30.

Rowe, J.S. 1972. *Forest regions of Canada*. Canadian Forestry Service, Publication No. 1300. Department of Fisheries and the Environment.

Saarnisto, M. 1974. The deglaciation history of the Lake Superior region and its climatic implications
Quaternary Research 4: 316-339.

Saarnisto, M. 1975. Stratigraphical studies on the shoreline displacement of Lake Superior. *Canadian*
Journal of Earth Sciences 12: 300-319.

Sanford, J.T. 1957. Geologic observations at the Sheguiandah site. *Canadian Field-Naturalist* 71: 13
148.

Shane, L.C.K. 1987. Late-glacial vegetational and climatic history of the Allegheny Plateau and the T
Plains of Ohio and Indiana, U.S.A. *Boreas* 16: 1-20.

Shane, L.C.K. 1989. Changing palynological methods and their role in three successive interpretation
the late-glacial environments at Bucyrus Bog, Ohio, U.S.A. *Boreas* 18: 297-309.

Shane, L.C.K. and K.H. Anderson. 1993. Intensity, gradients and reversals in late glacial environmen
change in east-central North America. *Quaternary Science Reviews* 12: 307-320.

Sly, P.G. and C.F.M. Lewis. 1972. *The Great Lakes of Canada-Quaternary geology and limnology*. 2
International Geological Congress, Montreal.

Spencer, J.W. 1891. Deformation of the Algonquin beach, and birth of Lake Huron. *American Journa*
Science 41: 12-21.

Stanley, G.M. 1934. Pleistocene potholes in the Cloche Mountains of Ontario. *Papers of the Michiga*
Academy of Science, Arts and Letters 19: 401-412.

Stanley, G.M. 1936. Lower Algonquin beaches of Penetanguishene Peninsula. *Geological Society of*
America Bulletin 47: 1933-1959.

Stanley, G.M. 1937a. Lower Algonquin beaches of Cape Rich, Georgian Bay. *Geological Society of*
America Bulletin 48 1665-1686.

Stanley, G.M. 1937b. Impounded early Algonquin beaches at Sucker Creek, Grey County, Ontario.
Michigan Academy of Science, Arts and Letters Papers 23: 477-495.

Stuiver, M. and P.J. Reimer. 1993. Extended ^{14}C data base and revised CALIB3.03 ^{14}C age calibratio
program. *Radiocarbon* 35: 215-230.

Stuiver, M., P.J. Reimer, E. Bard, J.W. Beck, G.S. Burr, K.A. Hughen, B. Kromer, G. McCormac, J.
der Plicht and M. Spurk 1998. INTCAL98 radiocarbon age calibration, 24,000-0 cal BP:
Radiocarbon 40: 1041-1083.

Tackman, G.E., D.R. Currey, B.G. Bills and T.S. James. 1998. Paleoshoreline evidence for postglaci
tilting in southern Manitoba. *Journal of Paleolimnology* 19: 343-363.

Taylor, F.B. 1897. The Nipissing-Mattawa River, the outlet of the Nipissing Great Lakes. *The Ameri*
Geologist 20: 65-66.

Terasmae, J. 1967. Postglacial chronology and forest history in the northern Lake Huron and Lake Superior regions. In *Quaternary Paleoecology*, edited by E.J. Cushing and H.E. Wright, Jr., pp. 45-58. New Haven: Yale University Press.

Terasmae, J. 1968. A discussion of deglaciation and the boreal forest history in the northern Great Lakes region. *Proceedings of the Entomological Society of Ontario* 99: 31-43.

Tovell, W.M. 1978. Notes on the Quaternary geology and the Bruce Peninsula, entrance to Georgian Bay and Manitoulin Island. In *Geology of the Manitoulin Area*, edited by J.T. Sanford and R.E. Mosher, pp. 91-92. Michigan Basin Geological Society, Special Paper 3.

Tovell, W.M., J.H. McAndrews, C.F.M. Lewis, T.W. Anderson and G.D. Hobson. 1972. Geological reconnaissance of Georgian Bay - a preliminary statement. *15th Conference on Great Lakes Research, International Association for Great Lakes Research*. p. 15.

Tremblay, M. and Y. Begin. 2000. The influence of black spruce to the climatic influence of Robert-Bourassa Reservoir in northern Quebec. *Ecoscience* 7: 228-236.

Walcott, R.I. 1972. Late Quaternary vertical movements in eastern North America: quantitative evidence of glacio-isostatic rebound. *Reviews of Geophysics and Space Physics* 10: 849-884.

Walker, P.C. and R.T. Hartman. 1960. The forest sequence of the Hartstown bog area in western Pennsylvania. *Ecology* 41: 461-474.

Warner, B.G., R.J. Hebda and B.J. Hann. 1984. Postglacial paleoecological history of a cedar swamp, Manitoulin Island, Ontario, Canada. *Palaeogeography, Palaeoclimatology, Palaeoecology* 45: 301-345.

Webb, T. III. 1974. A vegetational history from northern Wisconsin: evidence from modern and fossil pollen. *The American Midland Naturalist* 92: 12-34.

West, R.G. 1961. Late and postglacial vegetational history in Wisconsin, particularly changes associated with the Valders re-advance. *American Journal of Science* 259: 766-783.

Williams, A.S. 1974. *Late glacial-post-glacial vegetational history of the Pretty Lake region, northeastern Indiana*. Washington, D.C.: Department of the Interior, United States Geological Survey Professional Paper 686-B.

Wright, H.E., Jr. 1976. The dynamic nature of Holocene vegetation, a problem in paleoclimatology, biogeography, and stratigraphic nomenclature. *Quaternary Research* 6: 581-596.

Wright, H.E., Jr., and W.A. Watts. 1969. *Glacial and vegetational history of northeastern Minnesota*. Minnesota Geological Survey, Special Publication Series 11, 59 p.

Wright, H.E., Jr., T.C. Winter and H.L. Patten. 1963. Two pollen diagrams from southeastern Minnesota: problems in the late- and postglacial vegetation history. *Geological Society of America Bulletin* 74: 1371-1396.

Yu, Z. 2000. Ecosystem response to Lateglacial and early Holocene climate oscillations in the Great Lakes region of North America. *Quaternary Science Reviews* 19: 1723-1747.

Yu, Z.C. and U. Eicher. 1998. Abrupt climate oscillations during the last deglaciation in central Nort America. *Science* 282: 2235-2238.

Yu, Z. and H.E. Wright, Jr. 2001. Response of interior North America to abrupt climate oscillations North Atlantic region during the last deglaciation. *Earth-Science Reviews* 52: 333-369.

Zilans, A. 1985. *Quaternary geology of the Mackinac basin, Lake Huron.* M.Sc. thesis, University of Waterloo, 275 p.

Chapter 9

Geological History of an Important Paleoindian Manufacturing Site: Sheguiandah, Manitoulin Island

Peter H. von Bitter

Abstract

Paleoindians who came to Sheguiandah 9500 years ago quarried white quartzite, deposited as blankets of sand during an initial erosional event in shallow Precambrian seas 2.2 billion years before. About 1.85 billion years ago, these sediments were folded and thrust upward into high mountains and were fused by heat and pressure into quartzite; these processes created in the quartzite planes of weakness called cleavage. The next 1.4 billion years consisted of exceedingly slow wearing down of these Precambrian mountains; this second major erosional event, and the unimaginably long time it took to wear these mountains down, is recorded at Sheguiandah by the presence of low, rounded, white quartzite knolls.

About 450 million years ago, the rising waters of a Late Ordovician tropical sea left their mark at Sheguiandah in the form of layered sediment containing marine fossils. The junction between the steeply dipping, rounded Precambrian rocks and the nearly horizontally bedded, younger fossiliferous sediment at Sheguiandah is a remarkable angular unconformity, one that is marked by the Mystic Ridge of archaeologists, a Late Ordovician beach storm ridge of quartzite boulders and cobbles.

Although still present at higher elevations to the south, all traces of a third submergence by a Silurian tropical sea, about 440 million years ago, are missing at Sheguiandah. If Silurian sediments and fossils were ever deposited at Sheguiandah, then they were removed by a third major erosional cycle that began about 425 million years ago. The lowland in which Sheguiandah is located began to be carved out, a process that reached its maximum during the last Ice Age, when continental glaciers kilometers thick ground and scoured Sheguiandah down, on their way south. By about 10,000 years ago, Sheguiandah was ice free, but under the melt waters of glacial Lake Algonquin. As the waters slowly dropped, the quartzite knoll, immediately to the north of Sheguiandah was increasingly exposed and beach ridges and beach bluffs, each recording a new lake level, were created. About 9500 years ago, Paleoindians who lived on the shores of one of these post-glacial lakes, probably at the Korah Bluff level, were living in the Habitation Area of archaeologists, behind the Mystic Ridge (Korah) beach ridge, and were selectively mining quartzite from *in situ* bedrock sources, as well as possibly from the boulders and cobbles concentrated in Mystic Ridge.

Résumé

Les Paléoindiens sont arrivés à Sheguiandah il y a 9500 ans pour extraire le quartzite blanc qui, 2,2 milliards d'années auparavant, avait formé un lit de sable dans des mers peu profondes

The Sheguiandah Site: archaeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario, edited by P.Julig. Canadian Museum of Civilization, Archaeological Survey of Canada, Mercury Series Paper 161, 2002.

précambriennes. Il y a environ 1,85 milliard d'années, ces sédiments a été propulsés et intégré dans des grandes chaînes de montagne, fusionneés par la chaleur et la pression pour former le quartzite. Ces processus ont crée dans le quartzite des plans de faiblesse appelées clivages. Ensuite, pendant 1,4 milliard d'années, les montagnes précambriennes ont lentement glissé laissant dans leur sillage une série de pinacles arrondis peu élevés de quartzite blanc.

Il y a environ 450 millions d'années, les eaux montantes d'une mer tropicale de l'ordovicien récent ont laissé leur marque à Sheguiandah sous forme de couches de sédiments contenant des fossiles. La jonction entre le roc précambrien érodé et abrupt et le lit horizontal de jeunes sédiments fossilifères à Sheguiandah est d'une discordance angulaire remarquable. L'aspect le plus notable de cette discordance est une crête de tempête constituée de rochers et de galets de quartzite qui bordent le pinacle de quartzite précambrien à Sheguiandah – la Mystic Ridge des archéologues.

Bien que l'on note toujours la présence, à des altitudes plus élevées au sud, d'une troisième submergence par une mer tropicale silurienne il y a environ 440 millions d'années, aucune trace y est visible sur ce site. Sheguiandah a par la suite subit une érosion majeure débutant il y a environ 425 millions d'années et dont le point culminant s'est situé à l'époque glaciaire lorsque des glaciers continentaux ont décapé le sol canadien. Il y a environ 10,000 ans, il n'y avait plus de glace à Sheguiandah, sauf sous les eaux du lac glaciaire Algonquin. À mesure que les eaux se retiraient, elles exposaient le pinacle de quartzite situé immédiatement au nord de Sheguiandah, créant des crêtes et des escarpements de plage qui témoignent de chaque niveau du lac. Il y a environ 9500 ans, les Paléoindiens qui vivaient sur les rives de l'un de ces lacs post-glaciaires, probablement au niveau de l'escarpement de Korah derrière la crête de plage, exploitaient sélectivement autant le quartzite *in situ* du socle rocheux que le rochers et les galets de Mystic Ridge.

Introduction

The Paleoindians who worked and lived at Sheguiandah 9500 years ago (Barnett *et al.* 1991; Barnett 1991) could not have known that geology had had a major effect on their lives. While they were undoubtedly interested in geology, at least in its applied, practical aspects, they could probably not have imagined either the antiquity of Sheguiandah, or the sometimes dramatic geologic events that had shaped it. The most startling of these, and ultimately probably the reason why they came to Sheguiandah, was the tempering of the rock they were quarrying in the furnaces of colliding continents, 1.85 billion years before; this event would have been as unimaginable to them, as it still is to us today. Easier to understand, but still a powerful image, was the concentration by a tropical sea of a quartzite boulder and cobble storm ridge, Mystic Ridge, 1.4 billion years later. Perhaps the intuitively easiest geological event for the Sheguiandah Paleoindians to comprehend would have been the most recent – the melting and moving back of the thick continental glaciers, and the resultant flooding of much of the landscape, at the end of the last Ice Age, 10,000 years ago. These were people who lived in a periglacial environment and either they, or their ancestors, had experienced and survived the harsh environments of the waning Ice Age first-hand. Most of today's Sheguiandah was flooded 9500 years ago and the highest quartzite knoll (Figure 9.1) was an island in Lake Algonquin, the large lake that preceded Lake Huron (Sly and Lewis 1972; Barnett *et al.* 1991; Barnett 1991).

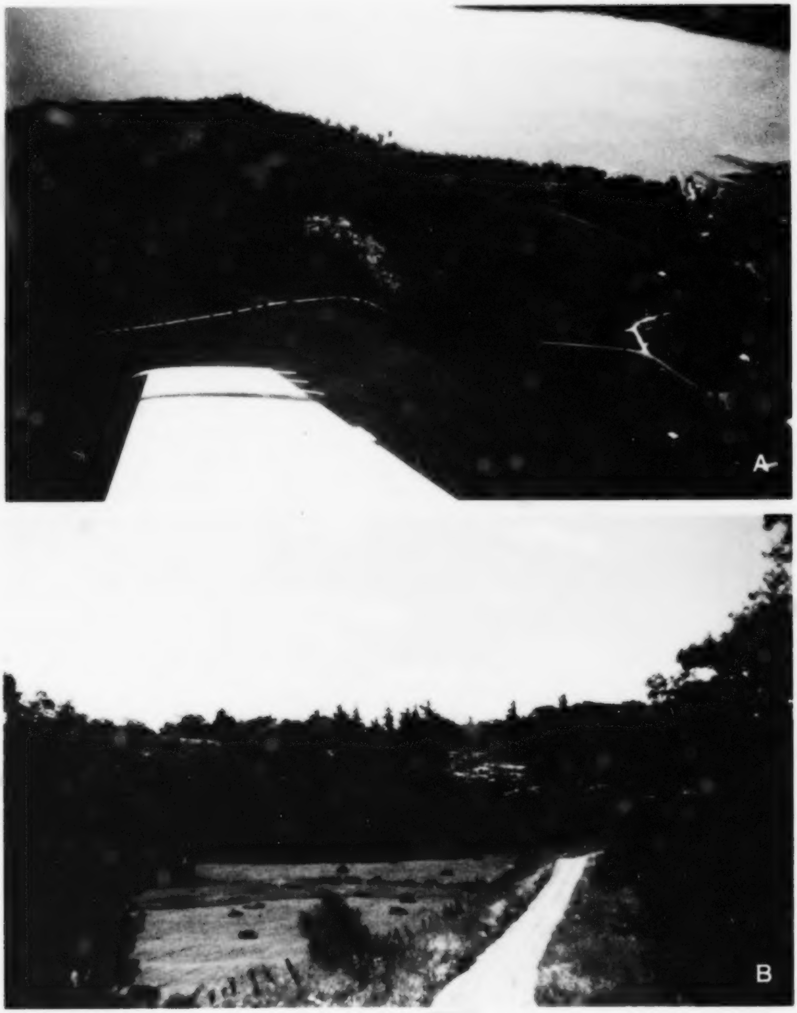


Figure 9.1. A) Quartzite knoll on which Sheguiandah Paleoindian site is located (above and to the right of aircraft wing-tip), immediately northeast of village of Sheguiandah; aerial view looking east at bare northern face of quartzite knoll. B) Quartzite knoll on which Sheguiandah Paleoindian site is located; view south at steep northern face [photograph by P.L. Storck 1970]. The road in foreground of both A and B is the gravel road that was part of the old highway between South Baymouth and Little Current, prior to being bypassed by the present paved Highway 6.

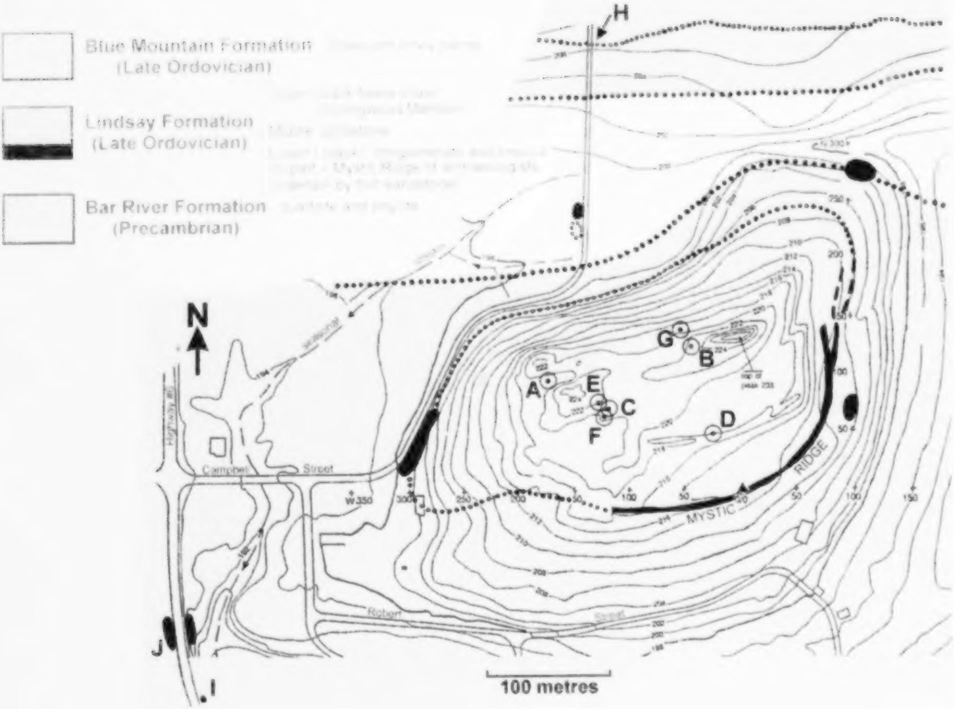

Blue Mountain Formation
(Late Ordovician)
Lindsay Formation
(Late Ordovician)
Middle: limestone
Bar River Formation
(Precambrian)
quartzite and phyllite
H
N
Highway 6
Campbell Street
Robert Street
MYSTIC
RIDGE
A
B
C
D
E
F
G
I
J
W350
300
250
200
150
100
50
0
50
100
150
100 metres

Figure 9.2. Distribution of main rock types at the Sheguiandah Paleoindian site and immediately adjacent area. Geological sketch map based on 1992 field work, on Sly and Lewis (1972) and Ontario Division of Mines Map 2247 (1972). The Blue Mountain Formation was not observed in outcrop, but occurs at Sheguiandah (Ontario Division of Mines Map 2247). Base map, with north-south and east-west grid, supplied by Archaeological Services Inc. Sites A-J record sample sites or significant outcrops. Contour interval is 2 m. Dotted lines denote geological contacts between formations.

Geological History of Sheguiandah

Sheguiandah is the result of a long, and at times dramatic, geological history – one that can be read from the identity, nature, distribution, and relationships of its rocks (Figures 9.2, 9.3). In order to understand how Sheguiandah came to look the way it does, why Paleoindian people came here, and how both very ancient, and more recent, geological events impacted on them, it is necessary to understand that history.

The oldest rocks at Sheguiandah, forming the 'basement', are the white quartzites and dark phyllites of the Bar River Formation (Sanford 1978; Johnson and Rong 1989; Robertson 1990) originally deposited as blankets of sand and mud about 2.2 billion (2,200 million) years ago dur-

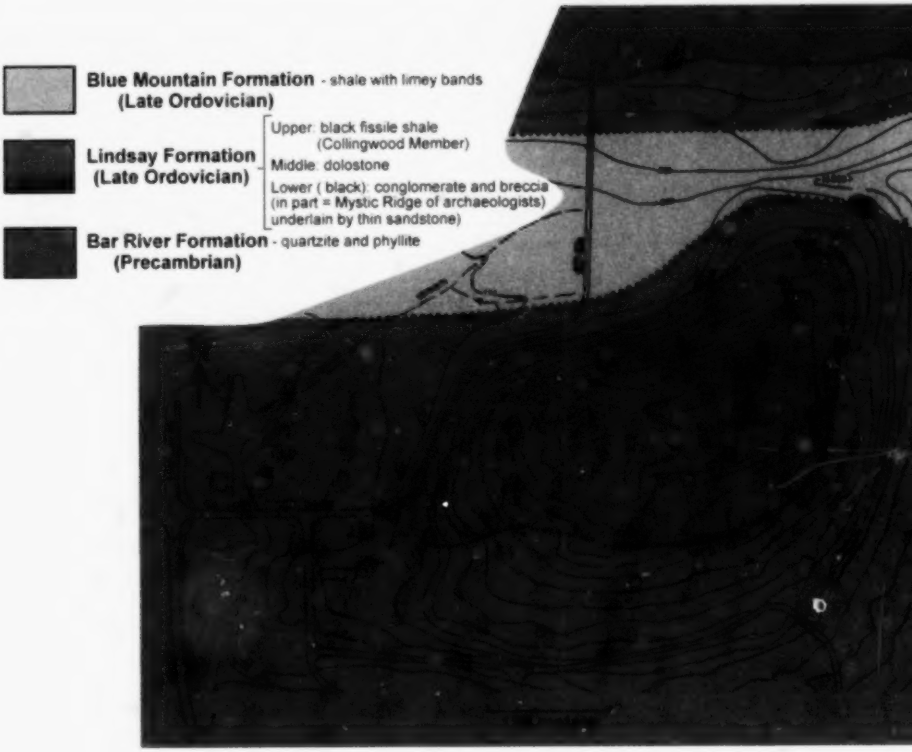

Blue Mountain Formation - shale with limey bands
(Late Ordovician)
Lindsay Formation
(Late Ordovician)
Upper: black fissile shale
(Collingwood Member)
Middle: dolostone
Lower (black): conglomerate and breccia
(in part = Mystic Ridge of archaeologists)
underlain by thin sandstone)
Bar River Formation - quartzite and phyllite
(Precambrian)
D

Figure 9.2. Distribution of main rock types at the Sheguiandah Paleoindian site and immediately adjacent are Geological sketch map based on 1992 field work, on Sly and Lewis (1972) and Ontario Division of Mines Ma 2247 (1972). The Blue Mountain Formation was not observed in outcrop, but occurs at Sheguiandah (Ontario Division of Mines Map 2247). Base map, with north-south and east-west grid, supplied by Archeological Serv Inc. Sites A-J record sample sites or significant outcrops. Contour interval is 2 m. Dotted lines denote geologi contacts between formations.

Geological History of Sheguiandah

Sheguiandah is the result of a long, and at times dramatic, geological history – one th be read from the identity, nature, distribution, and relationships of its rocks (Figures 9.2, 9 order to understand how Sheguiandah came to look the way it does, why Paleoindian p came here, and how both very ancient, and more recent, geological events impacted on the necessary to understand that history.

The oldest rocks at Sheguiandah, forming the 'basement', are the white quartzites an phyllites of the Bar River Formation (Sanford 1978; Johnson and Rong 1989; Robertson originally deposited as blankets of sand and mud about 2.2 billion (2,200 million) years ag

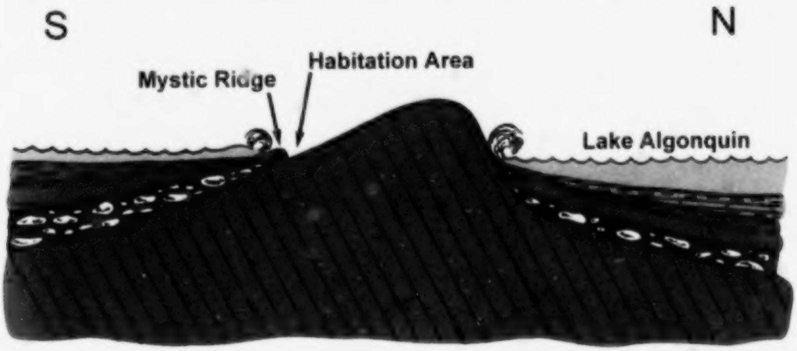

S
N
Mystic Ridge
Habitation Area
Lake Algonquin

Figure 9.3. Schematic geological cross-section of the quartzite knoll to the north of Sheguiandah during the Korah phase of Lake Algonquin, showing Mystic Ridge and the Habitation Area. Colours as in Figure 9.2.

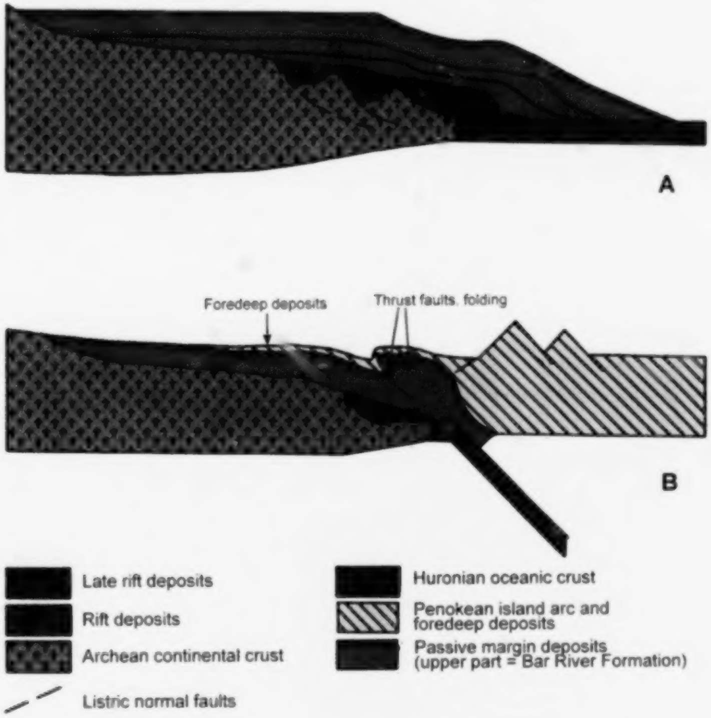

A
Foredeep deposits
Thrust faults, folding
B
Late rift deposits
Rift deposits
Archean continental crust
Listric normal faults
Huronian oceanic crust
Penokean island arc and foredeep deposits
Passive margin deposits (upper part = Bar River Formation)

Figure 9.4. Schematic cross-sections of A) possible depositional setting; and B) deformation and metamorphism of the Huronian Supergroup, of which the Bar River Formation (red, dotted) is the uppermost preserved member. A represents the passive continental margin developed above an earlier rift; B shows collision of the continental block with an island arc. Adapted from Bennett *et al.* (1991).

Table 9.1: Geological History of Sheguiandah.

Time	**Event**	**Evidence at Sheguiandah and Vicinity**
9,500 years ago	Continuing erosion. Lake Algonquin's water level continues to drop. Lake Algonquin forms from the melting and receding Wisconsin continental glacier. Almost all of Manitoulin Island, including Sheguiandah, is covered by water.	Various wave cut bluffs including Sheguiandah, Korah and Nipissing bluffs; evidence of presence of Paleoindians on Korah bluff. Lake Algonquin beach deposits.
~35,000-10,000 years ago	Wisconsin Glaciation—the last advance and retreat a continental glacier across Sheguiandah.	Final glacial rounding and erosion of landscape around Sheguiandah. Deposition of glacial till.
1.6 million years ago	Start of Ice Age; many continental glaciers, a kilometre or more thick, advance and retreat across Sheguiandah. Start of fourth great erosion event.	Rounding and planing off of existing topography; deposition of glacial sands and gravels; removal of preceding record by each new glacial advance.
425 million years ago	Start of third great erosion event.	Erosion of lowland around Sheguiandah.
440 million years ago	Submergence by a Silurian tropical sea.	-----------
450 million years ago	Submergence by an Ordovician tropical sea; deposition of marine sediment containing shells, etc.; creation of storm beach called Mystic Ridge by archaeologists. Second great erosion event	Mystic Ridge; outcrops of boulder conglomerate; dolostone (originally limestone) and shale containing marine fossils. Erosion of Precambrian mountains to form relatively low rounded quartzite hills.
1.85 billion years ago	High mountains thrust upward as a result of continental collision. Folding and metamorphism of sandstones and shales	Inclined beds of quartzite and phyllite, with good cleavage, formed by heat and pressure from sandstones and shales, respectively.
Between 2.2 and 1.85 billion years ago	'Hardening' (lithification) of sediments.	Sands and muds became sandstones and shales, respectively.
2.2 billion years ago	Laying down of sediment (derived from the wearing down of older continent) on ancient sea bottom. First great erosion event.	Sands and muds.
More than 2.2 billion years ago	Formation of an earlier and smaller North American continent.	

ing the Proterozoic Eon (Bennett *et al.* 1991). They were laid down on the margins of, or on an earlier and smaller North America formed over 2.5 billion years ago during the Archean Eon (Thurston 1991). The blankets of sand and mud have been interpreted as having been laid down either at the margins of a shallow Precambrian sea (Robertson and Card 1972; Wright and Rust 1985), or as wind-blown aeolian deposits on land (Robertson 1986). Although microbial life flourished in Precambrian seas, their fossil remains are rare, and have not been found at Sheguiandah.

The Proterozoic sands and muds deposited at Sheguiandah compacted and cemented over millions of years, 'hardening' into sandstones and shales with distinct layers. There was abundant time for these normal geological processes to take place; in fact, except for a poorly-known folding event prior to the intrusion of the Nipissing diabase (Card 1976; Stockwell 1982; Corfu and Andrews 1986), the next major event to affect this part of the Canadian Shield happened 400 million years later, about 1.85 billion years ago (Thurston 1991), when the ancient North American continent collided with one or more other 'drifting' land masses. The result was that flat-lying rocks at Sheguiandah were thrust upward, heated and altered, and also folded and faulted during a major plate-tectonic event called the Penokean Orogeny (Stearn *et al.* 1979; Corfu and Andrews 1986; Thurston 1991) (Figure 9.4). The sandstones and shales at Sheguiandah were not only metamorphosed, fused and hardened into quartzites and phyllites, respectively, but were pushed up into a high mountain chain. It was during this process of mountain building and folding that these, the oldest rocks at Sheguiandah, developed parallel planes of weakness called cleavage (Figure 9.5), a feature that was to affect their utility as a toolstone.

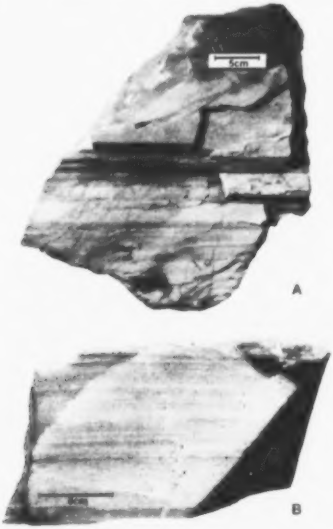


Figure 9.5. A) Bar River Formation quartzite with well-developed cleavage that shows up mainly as lines parallel to the 5 cm scale; location H (Figure 9.2). B) Bar River Formation quartzite with well-developed cleavage. Principal cleavage is defined by parallel lines on the face of specimen; secondary cleavage is seen as planes cutting those parallel lines and therefore creating diamond-shaped fragments; sample taken between localities B and G (Figure 9.2).

There is little evidence of anything happening at Sheguiandah for the next 1.4 billion years. However, even the absence of evidence *is* evidence and it took this immensely long period of time to wear down the mountains that had been pushed up during continental collision. At Sheguiandah this immensely long erosion event is best recorded in the wearing down and rounding of the quartzite knolls (Figure 9.1) and in the creation of the remarkable angular unconformity that separates the very ancient, steeply-dipping rocks from the much younger flat-lying rocks (Figures 9.6-9.8). The time represented by the irregular erosion surface that separates the underlying Precambrian metamorphosed quartzite and phyllite from the overlying unmetamorphosed Palaeozoic conglomerate, breccia, dolostone and shale is an incredible 1.35 billion (1,350 million) years.

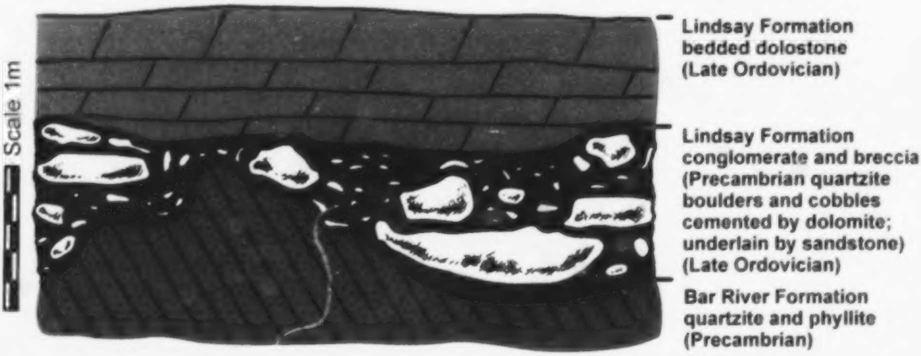

Scale 1m
Lindsay Formation bedded dolostone (Late Ordovician)
Lindsay Formation conglomerate and breccia (Precambrian quartzite boulders and cobbles cemented by dolomite; underlain by sandstone) (Late Ordovician)
Bar River Formation quartzite and phyllite (Precambrian)

Figure 9.6. Schematic sketch of angular unconformity representing 1,350 million years between steeply dipping Precambrian Bar River Formation quartzite and phyllite and subhorizontal Late Ordovician Lindsay Formation sandstone, conglomerate, breccia and dolostone; locality H (Fig. 9.2); adapted from Johnson and Rong (1989).

The nearly flat-lying, relatively soft, sedimentary rocks (Figures 9.6-9.8) that are present in the topographically lower areas of Sheguiandah are the result of submergence of Sheguiandah under a warm tropical sea, about 450 million years ago during the Late Ordovician Period (Liberty 1968, 1978; Sanford and Mosher 1978; Russell and Telford 1983) (Table 9.1). Initially, approximately 460 million years ago, the Ordovician sea covered, and left its record of slightly older marine sediment and fossils on La Cloche Island and Dreamer's Rock to the north of Sheguiandah (Johnson and Rong 1989) (Figure 9.9A). Approximately 10 million years later it reached the higher ground at Sheguiandah (Johnson and Rong 1989) (Figure 9.9D), depositing the slightly younger Lindsay Formation.

At Sheguiandah, the lowest (and therefore the oldest) sedimentary record of this tropical sea is the coarse sandstone, conglomerate and brecccia of the Lindsay Formation that is well exposed at the Sheguiandah roadcut (locality J, Figure 9.2). (These sedimentary rock types may also be characterized by the size of the particles, or clasts, in the original sediment; thus, the previous and subsequent reference to boulders and cobbles. Rounded boulders and cobbles resulted in conglomerates being formed; angular boulders and cobbles led to breccias). Slightly younger, but similarly formed, conglomerate and breccia fringes the Sheguiandah quartzite hill, like the remnant of hair around a bald man's head (Figures 9.2, 9.3). This ridge has been referred to as Mystic Ridge (Lee 1957, 1978, 1983; Sanford 1957, 1971, 1983).

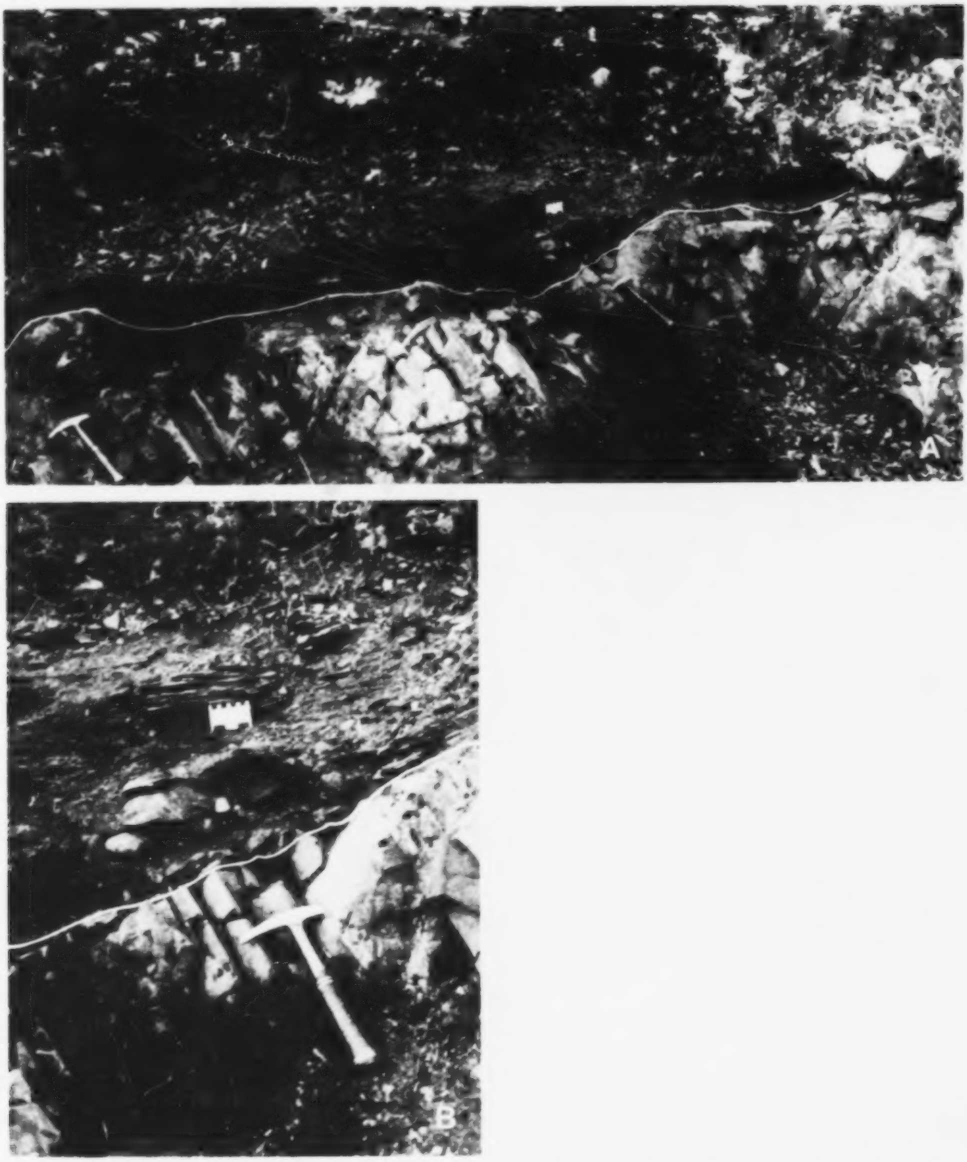


Figure 9.7. A,B) Overall and close-up views, respectively, of angular unconformity between steeply dipping Bar River Formation quartzite and subhorizontal Collingwood Member shale of the Lindsay Formation; hammer handle is parallel to the dip of the quartzite; note undulating (erosional) surface of unconformity (marked by white line). At this locality several rounded boulders and cobbles of the lower Lindsay Formation are directly overlain by the Collingwood Shale Member (immediately over the right hammer). Location H (Figure 9.2); after Johnson and Rong (1989).

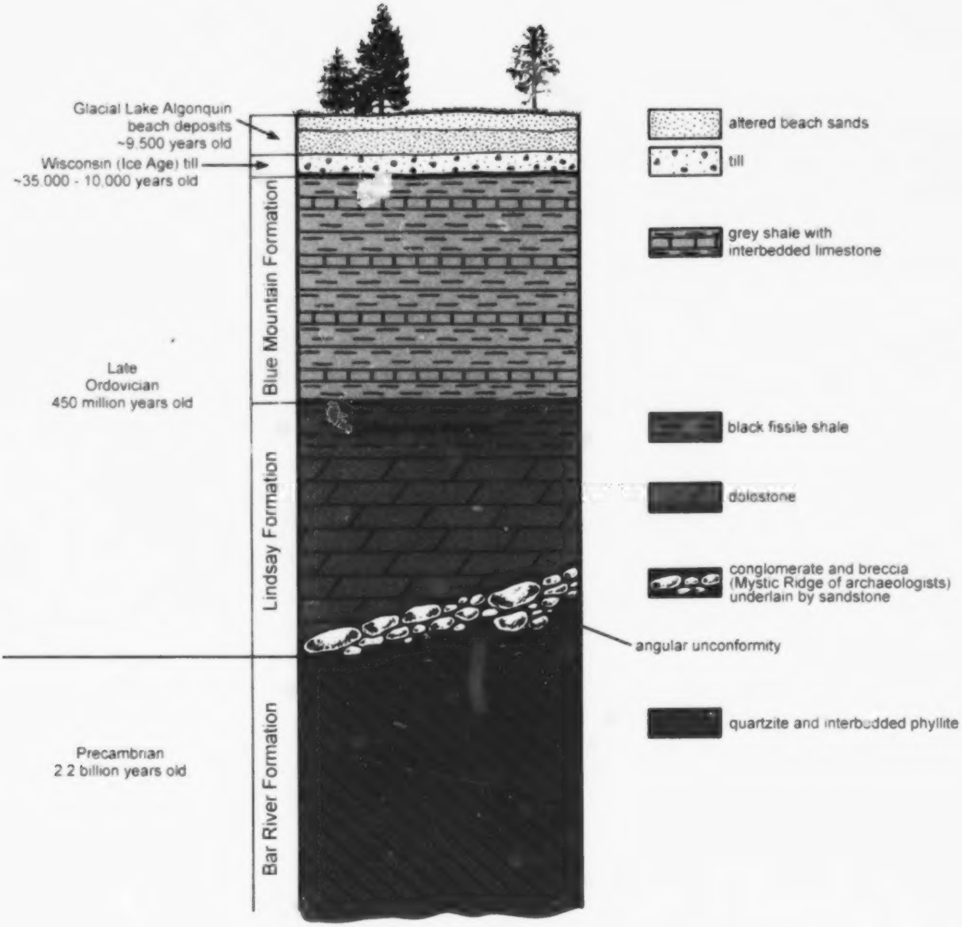

Glacial Lake Algonquin beach deposits ~9,500 years old
Wisconsin (Ice Age) till ~35,000 - 10,000 years old
Late Ordovician 450 million years old
Precambrian 2.2 billion years old
Blue Mountain Formation
Lindsay Formation
Bar River Formation
altered beach sands
till
grey shale with interbedded limestone
black fissile shale
dolostone
conglomerate and breccia (Mystic Ridge of archaeologists) underlain by sandstone
angular unconformity
quartzite and interbedded phyllite

Figure 9.8. Stratigraphic column of geological units at Sheguiandah. Colours as in Figure 9.2 (not to scale).

The most dramatic part of any sea is that point where the incoming waves release their energy, as they hit an immovable rocky shore (Figure 9.10). The record of this ancient wave action at Sheguiandah lies in the rounded and angular quartzite boulders and cobbles of the basal Lindsay Formation that form Mystic Ridge (Figure 9.11A), and which are exceptionally well exposed at the Sheguiandah roadcut (Figure 9.11B,C). When the incoming waves of the Ordovician sea broke over the quartzite island at Sheguiandah (Figure 9.10), the waves plucked, picked up, rounded, and concentrated quartzite boulders and cobbles into the arcuate ridge known as Mystic

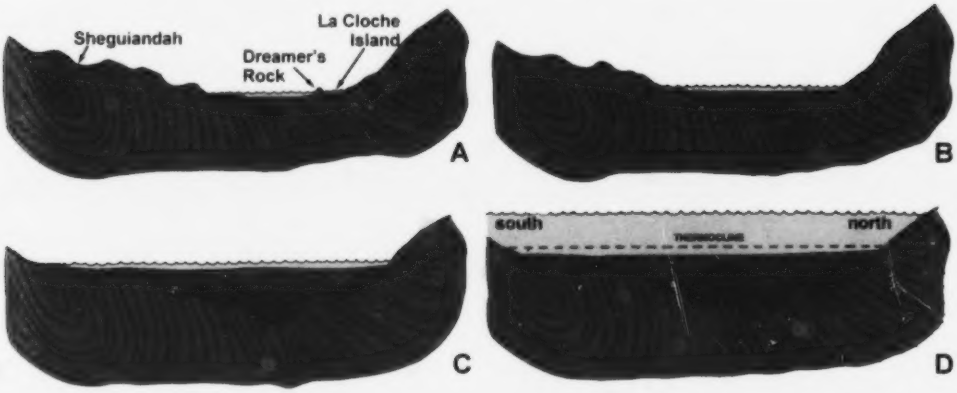


Figure 9.9. Schematic and vertically exaggerated cross-section between Sheguiandah in the south, and La Cloche Island and Dreamer's Rock to the north, showing gradual (A-D) infilling of the Precambrian basin by sediment deposited in the Ordovician sea. In this interpretation, environments were relatively uniform across the basin and only limited kinds of sediment were deposited at any one time. Adapted from Johnson and Rong (1989).

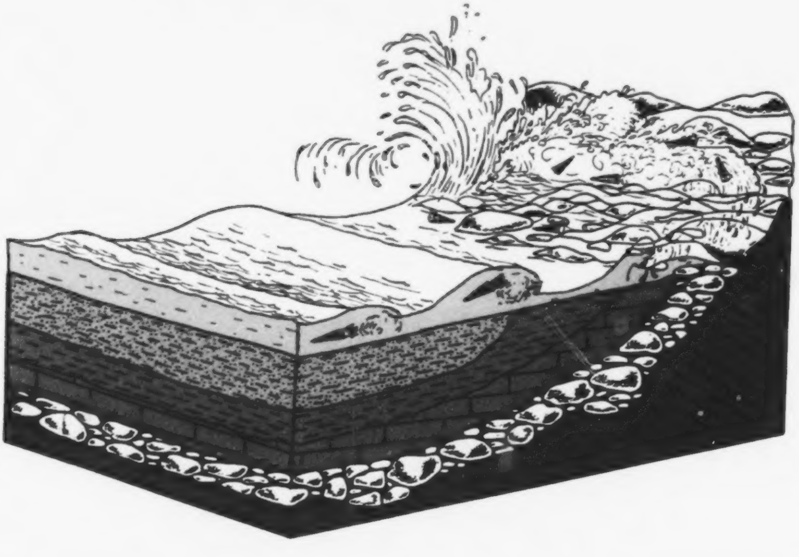


Figure 9.10. Schematic reconstruction of Late Ordovician sea impacting rocky shore of the quartzite knoll at Sheguiandah. In this depositional model, different kinds of sediment formed in different environments during any one time, i.e., the conglomerates and breccias formed in the highest energy 'swash' zone; limestone (later altered to dolostone) and shale formed in increasingly off-shore, lower energy environments. Note nautiloids thrown-about by waves. Adapted and modified from Kobluk (1990). Not to scale.

Ridge (Figure 9.2). The ancient rocky shore on which these younger quartzite boulders and cobbles accumulated is one of the best preserved anywhere (Johnson 1988; Johnson and Rong 1989) and shows other evidence of wave energy, such as percussion marks (Figure 9.12), formed as the large clasts collided with each other on the storm beach (Sanford and Mosher 1978; Kobluk 1990). Of special interest, in view of the destructive energy required to move and round these boulders and cobbles, is the preservation of Late Ordovician marine fossils in the dolomite matrix of the Lindsay Formation conglomerate and breccia (Figure 9.13A), or possibly encrusting a quartzite clast (Figure 9.13B).

The basal conglomerate and breccia is cemented by, and grades into, the overlying, light-tan coloured, variably crystalline, vuggy dolostone of the Lindsay Formation (Sanford and Mosher 1978) (Figures 9.2, 9.8, 9.14A) that is best seen on the east side of the Sheguiandah roadcut at locality J (Figure 9.2); here the Lindsay Formation is, because of the later alteration of the original limestone to dolostone, atypical (Sanford and Mosher 1978). Although marine fossils of the *Solenopora-Paratetradium* community (Figure 9.14B) are common at other nearby localities of the Lindsay Formation (Copper 1978), at Sheguiandah they appear to have been largely destroyed by the alteration of the original limestone to dolostone; in fact, the only fossils reported from this part of the Lindsay Formation on the east side of Highway 6 are two 1 m high algal mounds (Kobluk 1990). These dolostones are in turn overlain by the 2-8 m thick black, organic-rich, lime-bearing shales of the Collingwood Member of the Lindsay Formation (Copper 1978; Russell and Telford 1983) (Figures 9.2, 9.7, 9.8, 9.15A) that contain a modest marine fauna (Figure 9.15B-f) that for the most part lived above an organic-rich, but oxygen-deficient sea bottom (Copper 1971; Copper and Long 1993). These are succeeded gradationally by the 40-45 m-thick soft greenish-grey shales and thin limestone interbeds of the Blue Mountain Formation (Figures 9.2, 9.8, 9.16A) which are poorly exposed at Sheguiandah. This unit was deposited under less harsh, more open marine conditions and contains a diverse marine fauna, one that has been compared with the *Sowerbyella-Onniella* community (Bretsky 1969; Copper 1971, 1978) (Figure 9.16B).

The sequence of four sedimentary marine units that overlie the Precambrian quartzite unconformably (Figures 9.2, 9.8), record the progressive submersion of the ancient erosion surface by an Ordovician sea. What the exact relationship of these four units was to each other, when they were laid down, is controversial. In one interpretation, they were deposited successively in a basin in which the environment at any one time was essentially uniform throughout (Figure 9.9). Alternatively, each of these sedimentary units represents a different energy zone and a different environment that was deposited at the same time as the others (Figure 9.10).

There is no record of what happened at Sheguiandah during the next 450 million years, or so. Like the excruciatingly long break after the Precambrian continental collision and upthrusting of mountains, this doesn't mean a lack of activity – rather it indicates that any rock and fossil record of events at Sheguiandah after the Late Ordovician was destroyed and/or removed by later erosion. The sedimentary evidence of a second marine submergence, that of a Silurian tropical sea about 440 million years ago, is lacking at Sheguiandah; it occurs to the south and west of Sheguiandah (Ontario Division of Mines Map 2247, 1972) where, as the Niagara Escarpment, it forms the backbone of Manitoulin Island (Chapman and Putnam 1984). An im-

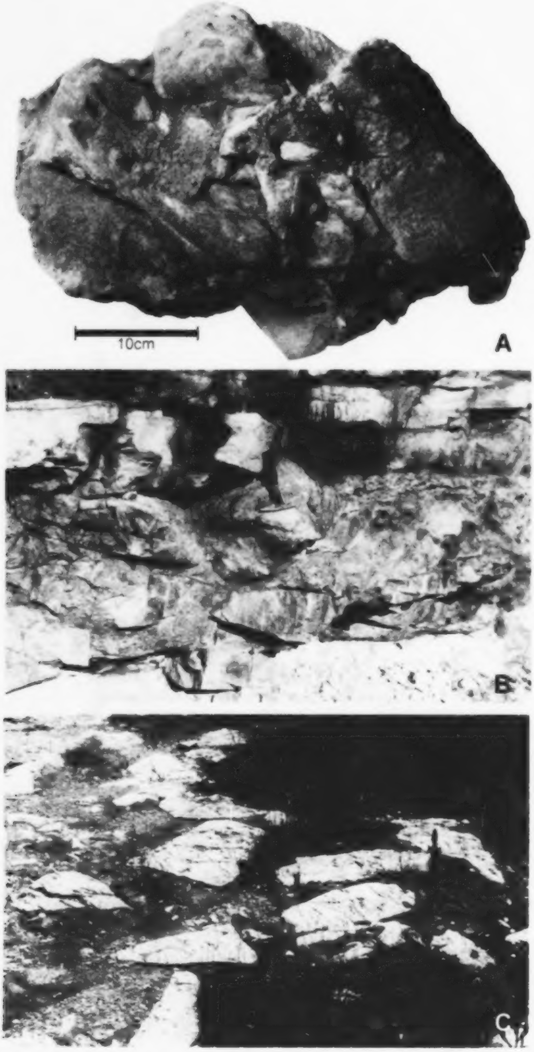


Figure 9.11. Conglomerate and breccia of the lower Lindsay Formation.
A) Rounded, cemented boulders and cobbles from test pit in Mystic Ridge, immediately south of Habitation Area;
B) *In situ*, angular boulders unconformably overlying the Bar River Formation quartzite and overlain by horizontally bedded Lindsay Formation dolostone (top); vertical cross-section of road-cut on east side of Highway 6 at locality J (Figure 9.2); hammer for scale;
C) *In situ*, angular boulders smoothed off by glacial ice; transverse (horizontal) section on upper surface of road-cut; west side of Highway 6 at locality J (Figure 9.2). No scale present, however, angular boulders about same size as those on opposite side of road (see Figure 9.11B).

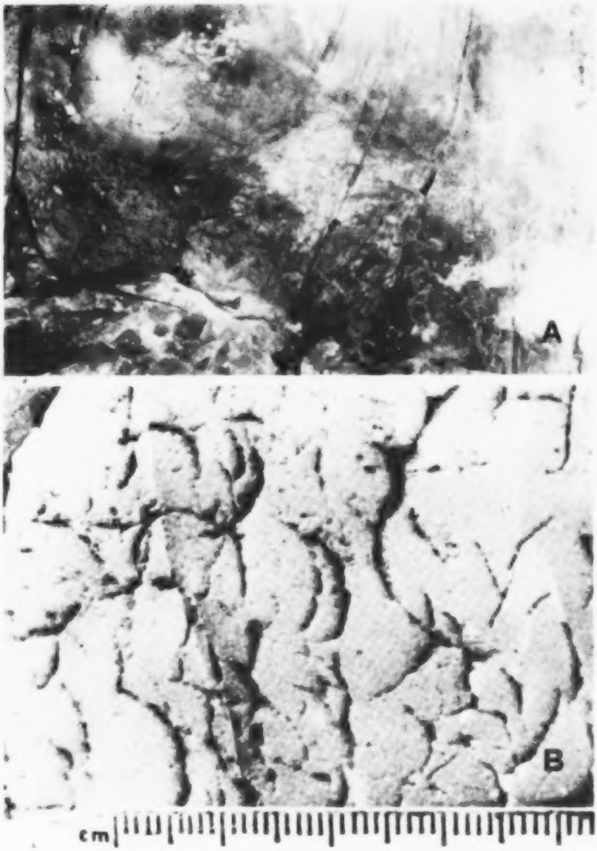


Figure 9.12. Percussion marks on quartzite boulder of the Lindsay Formation, the result of boulders colliding and impacting each other on a Late Ordovician rocky shore.
A) East side of road-cut on Highway 6 at locality J (Figure 9.2); coin (middle left) is 2.5 cm in diameter.
B) From Sanford and Mosher (1978).

portant, but almost imperceptable, boundary between the sediment deposited during the Ordovician and the Silurian seas, is exposed not far from Sheguiandah at Charleton Bay (Copper and Long 1993), and at Manitowaning and Kagawong West (Barnes and Bolton 1988; see also Kobluk 1984). It seems likely that Sheguiandah was covered by this Silurian sea; the sediment deposited in this sea must have been eroded and the Sheguiandah lowland carved out by the third great erosion event that started about 425 million years ago.

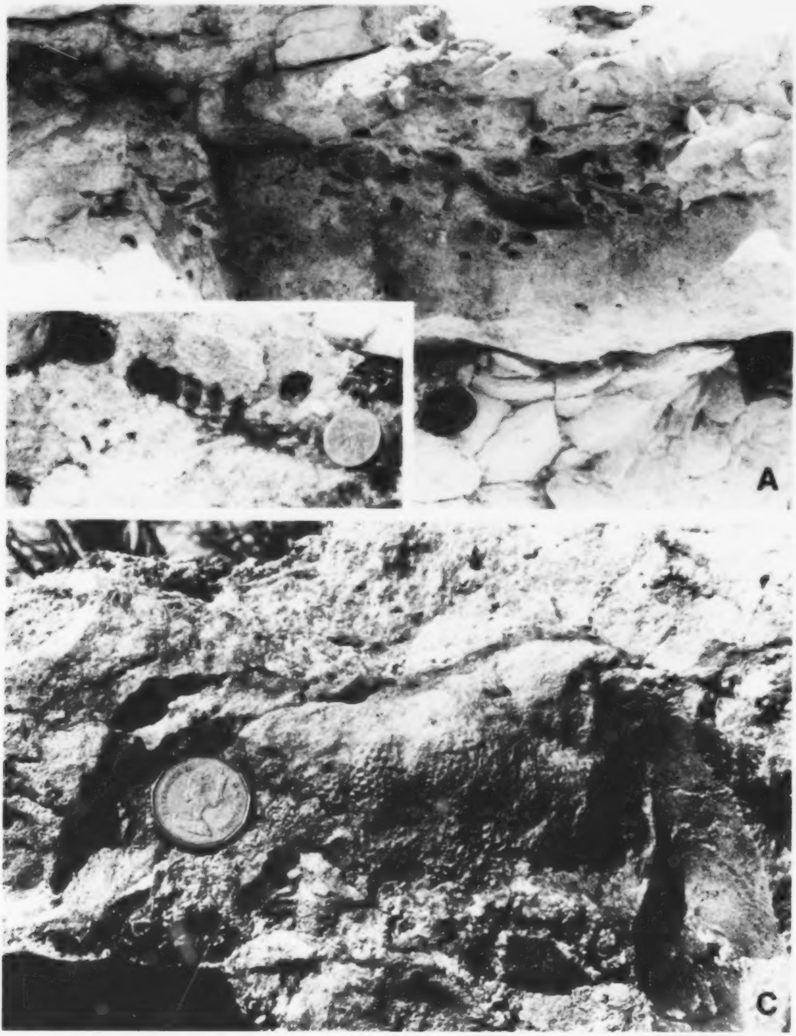


Figure 9.13. Fossil nautiloids and corals from the dolostone matrix of the conglomerate, lower Lindsay Formation, east side of road-cut on Highway 6 at locality J (Figure 9.2).
A,B) Moulds of conical nautiloid cephalopods; moulds in A are mostly circular cross-sections ('holes in the rock') of nautiloids; in B, a transverse section preserves ribbing of nautiloid shell. Coin in B is 1.8 cm in diameter.
C) Coral colony encrusting? quartzite boulder; below coin, and also to its right, pockets of crystallized dolomite. Coin is 2.5 cm in diameter.

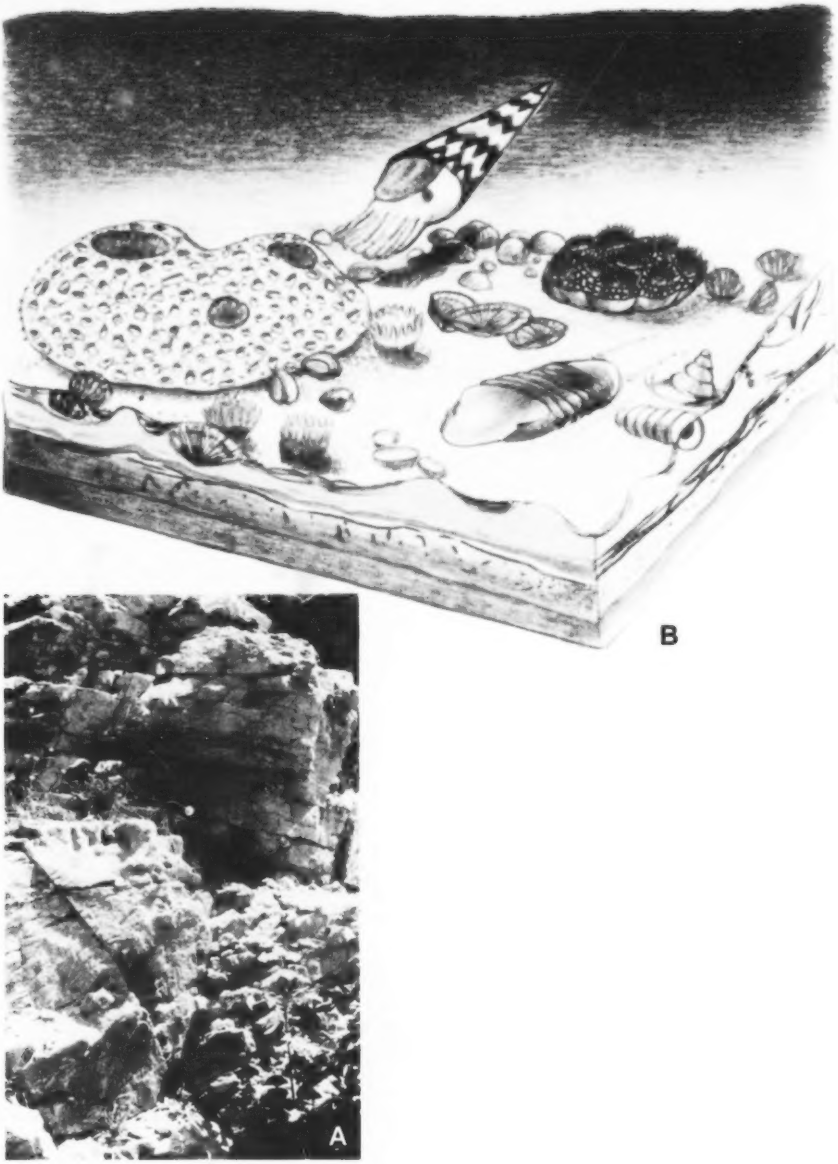


Figure 9.14. A) Horizontally bedded dolostone of the Lindsay Formation (upper half) overlying highly fractured Bar River Formation quartzite (lower half); east side of road-cut on Highway 6, locality J (Fig. 2); no scale, however, ~1.3 m of Lindsay Formation dolostone exposed.
B) Reconstructed *Solenopora-Paratetradium* community of the Lindsay Formation; based on well-preserved occurrences on Goat Island and at Little Current; after Copper (1978).

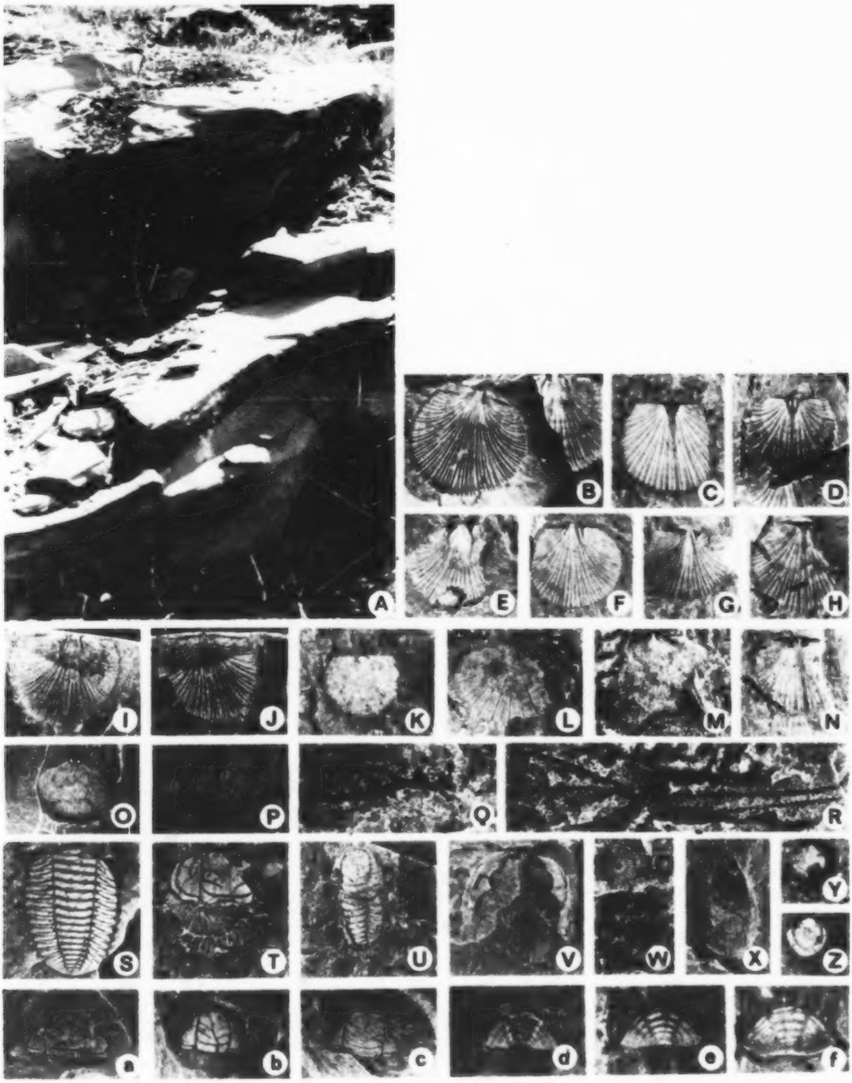


Figure 9.15. A) Black, carbonate-rich, fissile shale of the Collingwood Member of the Lindsay Formation; east side of road-cut on Highway 6, locality I (Figure 9.2); hammer (upper middle) for scale; B-P, X-Z) Fossil brachiopods, (Q-R) bryozoans, and (S-W, a-f) trilobites from the base of the Collingwood Member, Lindsay Formation, just above the angular unconformity with the Bar River Formation quartzite; locality H (Figure 9.2); modified from Johnson and Rong (1989). Variable magnifications; B-H) *Dalmanella* sp.; I-J) *Fardenia* sp.; K-L) *Paromalomena* sp.; M) *Rafinesquina*? sp.; N) *Onniella*? sp.; O-P) *Triplesia* sp.; Q-R) Unidentified bryozoans; S-W,a-f) *Triarthrus canadensis* Smith, 1861 [in W, note circular crinoid, or sea-lily, stems]; X) *Lingula* sp.; Y-Z) *Paracraniops* sp.

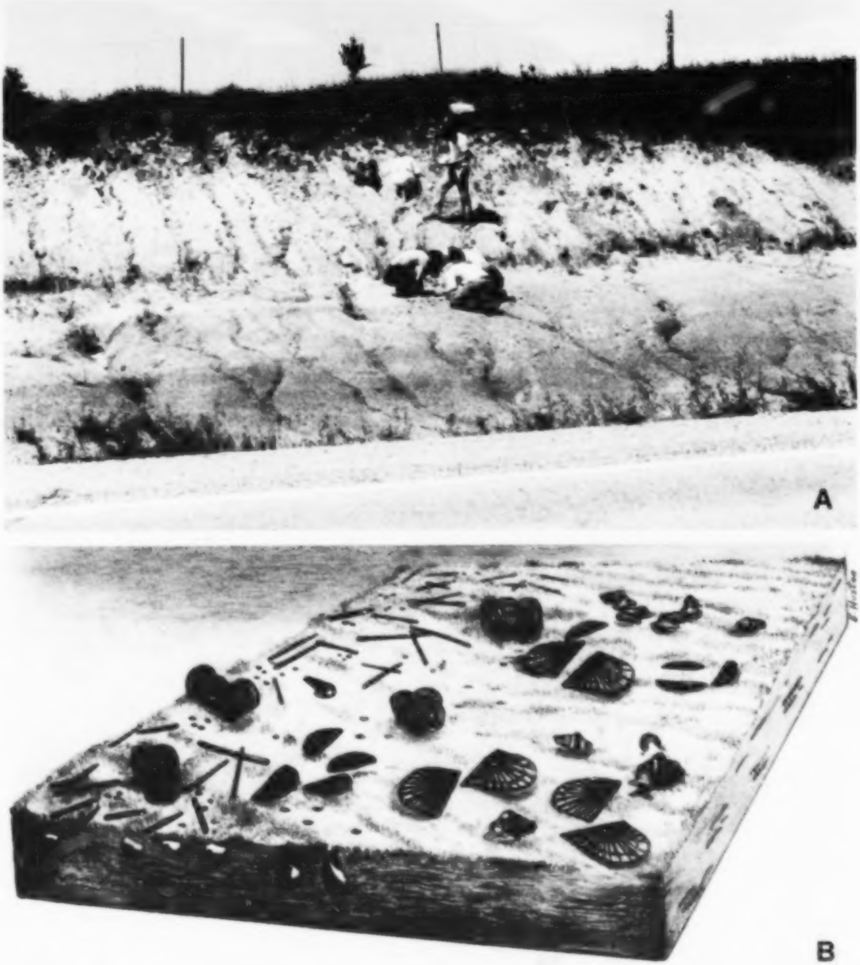


Figure 9.16. A) Blue Mountain Formation shale outcrop on west side of road-cut on Highway 6, 3.7 km south of Sheguiandah; stop 5 of Copper (1971). B) Reconstructed *Sowerbyella-Onniella* community of Bretsky (1969). This community, according to Copper (1971), is similar to the one found in the Blue Mountain Formation 3.7 km south of Sheguiandah.

The final geological drama that shaped Sheguiandah, and which is recorded there, began about 1.6 million years ago (Stanley 1989) when great continental glaciers a kilometre or more thick, moved southward across Sheguiandah on their way to northern and central United States (Fullerton 1986) (Figure 9.17). The features at Sheguiandah that had been coarsely carved and eroded by hundreds of millions of years of erosion were almost certainly accentuated by this glaciation; the valley in which Sheguiandah is situated was gouged out and scraped clean, and the white quartzite knolls became even more rounded. Ice ramming the steep northern face of the Sheguiandah quartzite knoll probably removed any Ordovician boulder beach, Mystic Ridge, that may have been present there; freeze-thaw processes may have opened fractures in the quartzite along old cleavage lines.

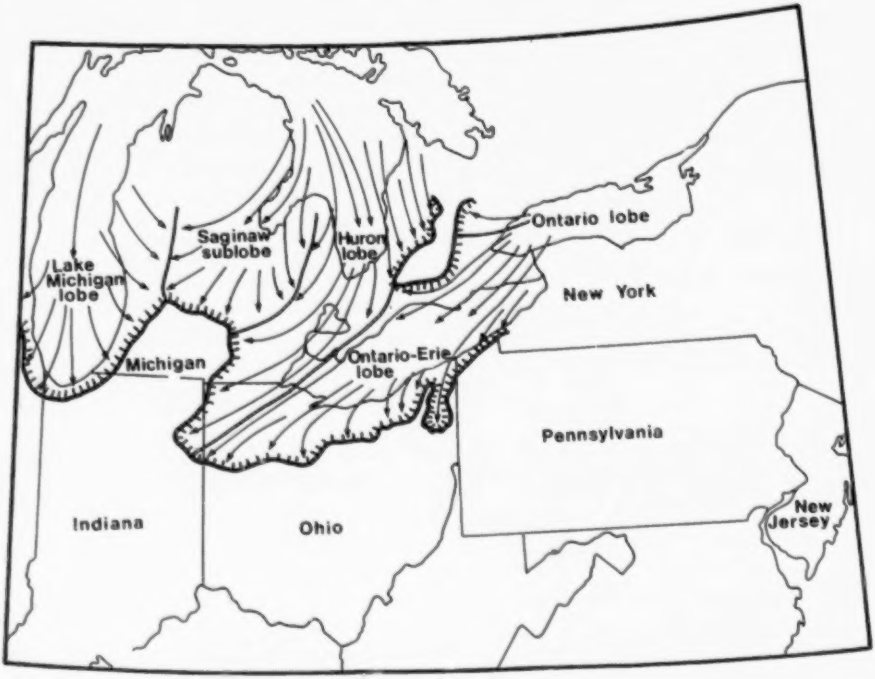


Figure 9.17. Glacial ice of the Wisconsin advance covering Great Lakes region, including Sheguiandah, 14,800 years ago (after Fullerton 1986).

The 'Ice Age" or Pleistocene Epoch that started in North America and Europe about 1.6 million years ago included up to 18 ice advances, separated by warmer ice retreats (Stanley 1989). During each of these ice advances the continental glaciers ground slowly over everything in their path, grinding, plucking and incorporating boulders, sand and other sediment into their load; the unsorted and unlayered rock debris deposited under these advancing glaciers is called 'till' (Stanley 1989). Although it was originally thought (Lee 1957, 1978, 1983; Sanford 1957, 1971, 1983) that a record of three glacial advances was preserved as three tills at Sheguiandah, it has now been shown that only the lowest of these is, in fact, a till; the other two are weathered beach deposits (Barnett *et al.* 1991; Barnett 1991). The only true till at Sheguiandah lies below the artifact-bearing layers (Barnett 1991) and probably records a glacial advance (Stanley 1989) during the last ice age, the Wisconsin.

Only after the ice lobes covering Sheguiandah (Figure 9.17) had melted, was it possible for the first Paleoindians to enter and explore the area. Even then this was not a simple and immediate possibility. Much of the land was still depressed and hadn't rebounded from the weight of the former thick continental ice masses (see Lewis 1970 for a consideration of post-glacial uplift on Manitoulin Island); consequently, water freed from the receding and melting glaciers flooded large areas. At maximum flooding, all of Manitoulin Island except High Hill, was covered by the waters of Lake Algonquin (Chapman and Putnam 1984), a body of water that was, at least right after ice recession, much larger than its successor, Lake Huron (Chapman and Putnam 1984). The shoreline of the highest level of Lake Algonquin is preserved as a raised-beach high above Sheguiandah (Sly and Lewis 1972) (Figure 9.18). What are preserved at and near Sheguiandah itself are the shore-line features of Lake Algonquin that developed as its water level dropped (Sly and Lewis 1972) (Figure 9.18). The Paleoindians at Sheguiandah were working, and possibly living in the Habitation Area, behind the beach deposits formed by one of these stages – probably the Korah phase (Barnett *et al.* 1991; Barnett 1991).

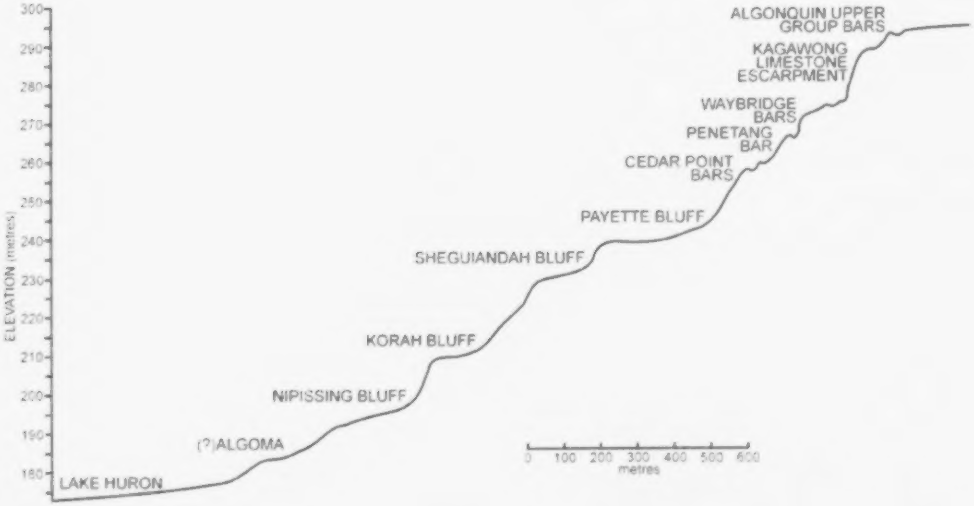


Figure 9.18 Shoreline bluff and bar features formed as glacial Lake Algonquin water levels dropped in the vicinity of Sheguiandah. Measured between Sheguiandah and Little Current (after Sly and Lewis 1972).

Paleoindian Utilization of Geological Resources

The main, and probably the only, geological resource obtained by Paleoindians at Sheguiandah was Bar River Formation quartzite. These Paleoindians seem to have had either little familiarity with, or limited access to, chert for producing tools (Eley and von Bitter 1989).

Chert is common in the Silurian age Fossil Hill Formation on Manitoulin Island, on the higher ground to the south and west of Sheguiandah (Eley and Jull 1982); chert from this formation was the preferred raw material of Paleoindians of southern Georgian Bay (Storck and von Bitter 1989) and southwestern Ontario (Deller 1979). The Lee Collection at the Canadian Museum of Civilization includes both a Paleoindian point made of Fossil Hill Formation chert, as well as Fossil Hill Formation chert (Patrick Julig, personal communication) and during the 1991 excavations at Sheguiandah, only a single non-diagnostic artifact and one un-worked piece of Fossil Hill Formation chert were recovered (see also, Storck, this volume; Julig and Mahaney, this volume). Chert may not have been available, or may have been available only to a limited degree, to the Sheguiandah Paleoindians because much of Manitoulin Island was still submerged by Lake Algonquin (Chapman and Putnam 1984) or because upland sources may still have been covered by remnant ice.

Evidence for Paleoindian quarrying activity at Sheguiandah includes excavations in the quartzite, and percussion marks made by hammerstones (Lee 1957, 1978, 1983; Russell and Telford 1983). The Paleoindians were likely selective in quarrying activities because the Bar River Formation varies in composition (Sanford 1978) and quality. Initial selection would have involved choosing raw materials with as few directional fracture systems (such as bedding, cleavage, or jointing) as possible – features that weaken stone and make it less suitable for tool manufacture. The northern one-third of the quartzite knoll at Sheguiandah (Figures 9.1, 9.2) appears to be more highly fractured, in the form of a well-developed cleavage (Figures 9.5, 9.19), than the more southerly two-thirds.

A second kind of selection probably practised by the Sheguiandah Paleoindians involved a preference for only 'good' raw material. The rock types that outcrop on the main quartzite knoll at Sheguiandah are not uniform and vary in composition; the purer, whiter quartzites (Figures 9.20A, B) tend to be harder, thus they form resistant ridges. The darker rocks (Figure 9.20D-F) are softer and less resistant, thus they occur in the small valleys on the quartzite knoll and underlie swampy areas. Paleoindians almost certainly recognized these differences in hardness and resistance, concentrating their efforts on exploiting the harder, purer raw materials. In general, the whiter the rock (Figure 9.20A, B), the cleaner the original Precambrian sand was when it was deposited. The rock that resulted after these sands were heated and fused by pressure tends to be exceedingly tough and essentially consists only of tightly interlocking quartz grains (Figure 9.21A, B), an ideal material for tool manufacture. The greener and darker the rock (Figure 9.20D-F), the more impure, or the muddier the sediment was originally; in this case, the metamorphic rock that resulted after application of heat and pressure, contains soft, fibrous, often elongated mineral grains (Figure 9.21D-F; see also Long *et al.* this volume). The tendency for the rock to break along lines of weakness within these minerals would likely make it less suitable for manufacturing tools. Quartzite with a brownish-green, almost soapstone-like quality, and having a slightly fibrous appearance (Figure 9.20C) was originally a sandstone containing some mud; although it contains enough quartz (Figure 9.21C) that it could have been used for tool manufacture, whether Paleoindians used this material, and with what frequency, requires examination of existing collections. The quantity of fibrous minerals in the matrix (Figure 9.21C) of the brownish-green quartzite (Figure 9.20C) suggests that the Paleoindians were unlikely to have used raw material darker than this.

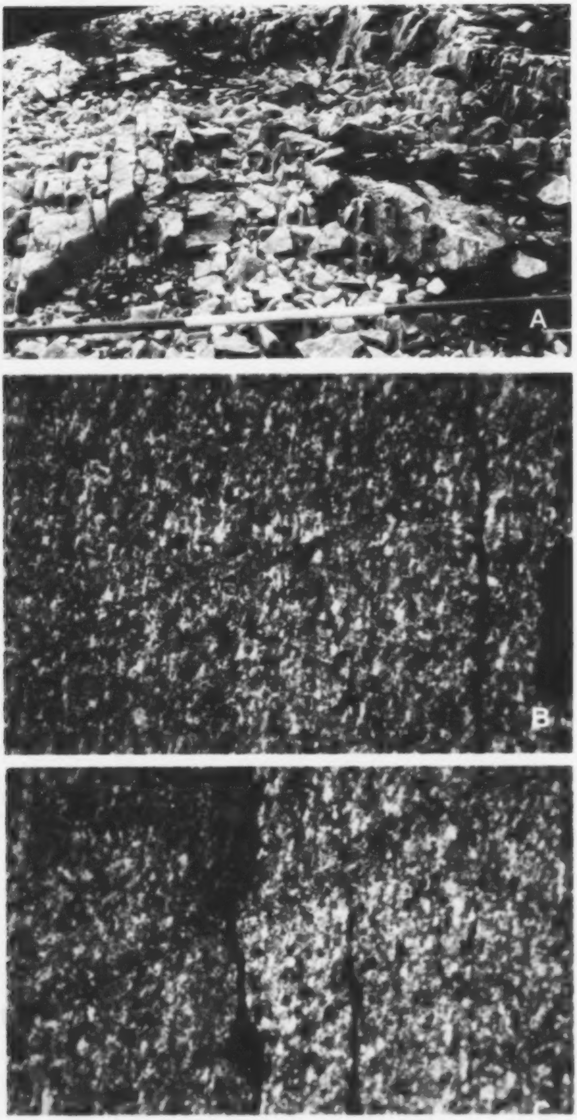


Figure 9.19. Cleavage in Bar River Formation quartzite.
A) Diamond-shaped cleavage fragments in outcrop; at or near locality G (Figure 9.2); bar across lower part of picture is ~ 1 m. B, C) Two intersecting cleavage planes in quartzite; thin-section under crossed nicols; between localities B and G (Figure 9.2), x 10 and x 10, respectively.

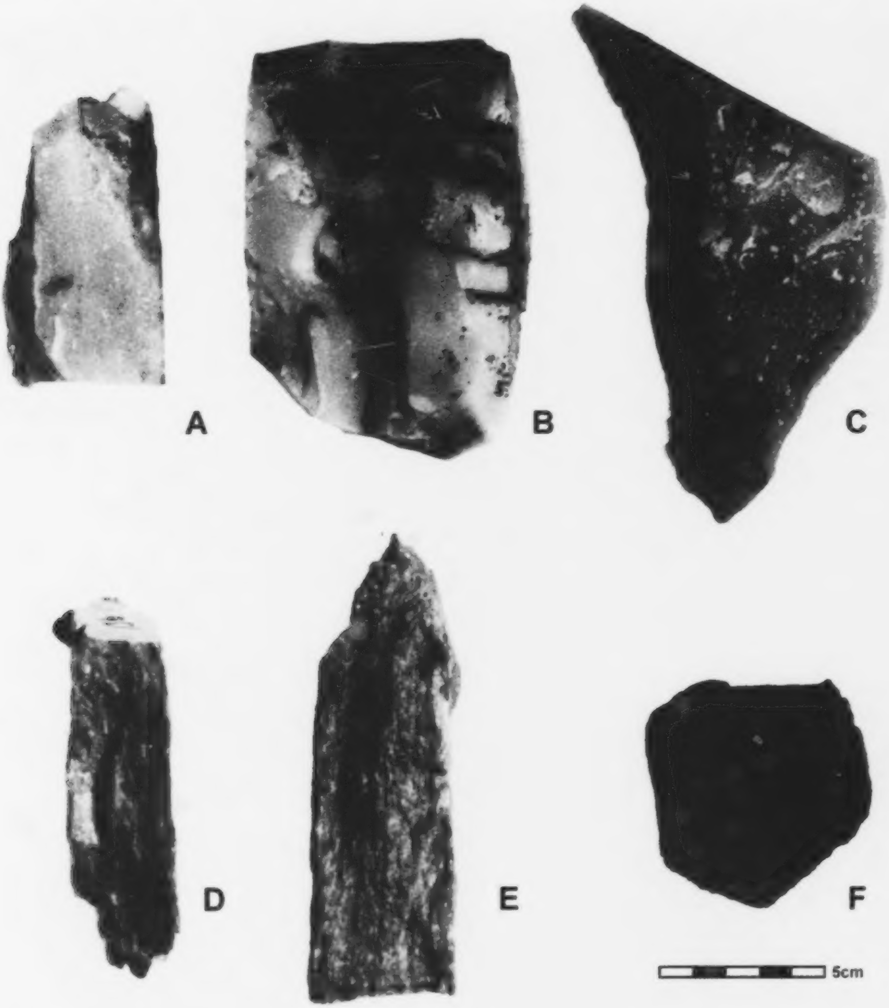


Figure 9.20. A-F) Rock samples from quartzite knoll on which Sheguiandah Paleoindian site is located, showing variation in rock types available for tool manufacture. Arrangement by colour (from pure white [A] to green [F]) reflects decreasing quartz content, increasing dark, fibrous silicate impurities and increasing unsuitability for tool manufacture. Localities A, B, C, D, E, and F, respectively (Figure 9.2).

The degree to which Paleoindians were quarrying quartzite from Mystic Ridge is unknown. Certainly the boulders and cobbles that armour the ridge would have provided a relatively accessible, easily quarried source of quartzite; the quartzite would, in a sense, have been 'pre-tested' for fractures and other imperfections on the Ordovician storm beach, and the weathering

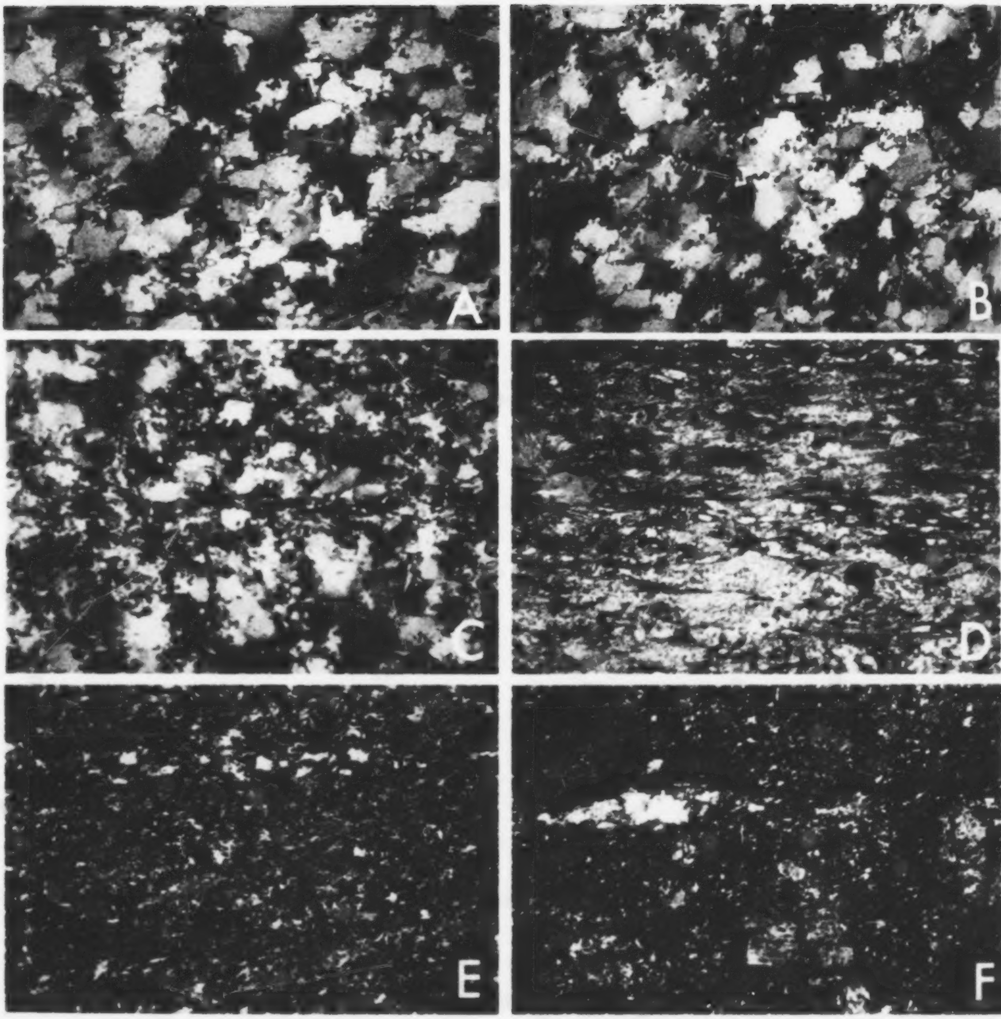


Figure 9.21. A-F) Thin-sections cut from rock samples of Figure 9.20, respectively; shown in same sequence and from same localities as in Figure 9.20. All under crossed-nicols. Quartz grains are subequidimensional and bluish-grey to black in colour; other silicates are fibrous, and green to red to brown in colour, A-E x34; F x17.
A, B) Quartzite showing interlocking quartz grains with few dark, fibrous silicate impurities;
C) Quartzite with interlocking quartz grains and noticeable increase in fibrous silicate minerals;
D-F) Phyllite with few interlocking quartz grains and increasingly higher content of fibrous silicate minerals.

of the softer dolostone matrix of Mystic Ridge over millions of years would have made the removal of quartzite boulders and cobbles relatively easy. Evidence of Paleoindian quarrying of Mystic Ridge, if it was ever present, has probably been destroyed by weathering during the last 9500 years.

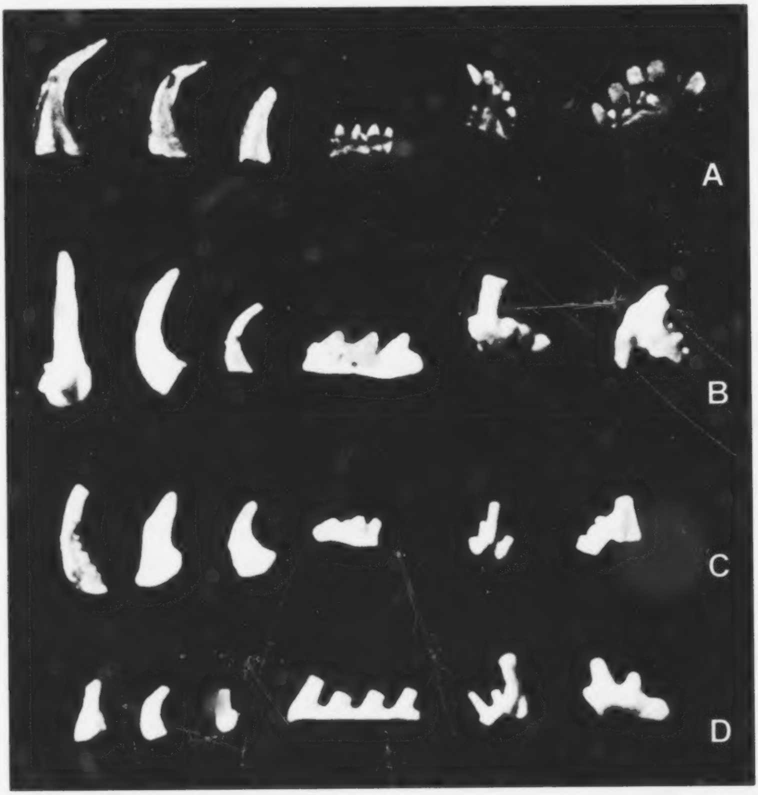


Figure 9.22. Ordovician phosphatic microfossils (conodonts) from Mystic Ridge (A), the two beach deposits in the Habitation Area (B, C), and the glacial till in the Habitation Area (D); no taxonomic variation noted. Preservation is best in conodonts from the bed-rock Mystic Ridge source (A); conodonts from beach deposits (B,C) are more fragmented and altered (whitened); those from glacial till (D) are most fragmented and altered (whitened). x 200.

Mystic Ridge as a Sediment Source

Many of the questions regarding the Sheguiandah site have a geological basis. Among these are the questions of how many tills are present and how many glacial advances occurred? The reinterpretation that tills 1 and 2 (Lee 1957, 1978, 1983; Sanford 1957, 1971, 1983) are most likely weathered nearshore or beach deposits of the Korah phase of postglacial Lake Algonquin (Barnett 1991), made it of interest to determine the source of these nearshore sediments.

The proximity of Mystic Ridge to the Habitation Area (Figure 9.3) raises the question of the degree to which the nearshore or beach deposits at the Habitation Area were derived from Mystic Ridge. One way of answering this is to determine whether the sediment of the potential source (Mystic Ridge) shares any physical, chemical or biological characteristics with that of the potential recipient nearshore or beach deposits. Comparison of Ordovician marine microfossils called conodonts (Barnes *et al.* 1978) from the dolostone matrix of Mystic Ridge, from the two weathered beach deposits, and from the underlying till (Barnett 1991) in the Habitation Area suggests that sediment transfer could have occurred from Mystic Ridge to the Habitation Area immediately to the north. Taxonomically, the same, or similar, conodonts were recovered from all four sources (Figure 9.22). Conodonts from dolomite cementing the Mystic Ridge conglomerate (Figure 9.10A) are an unaltered amber colour and are the most abundant and best preserved (Figure 9.22A). Those from the nearshore or beach deposits are an altered white colour (Figure 9.22B,C), as are those from the underlying till (Figure 9.22D). The principal difference between the beach and the till conodonts is in preservation and abundance; those from the till being more abraded and less abundant (Figure 9.22D).

Boulders and cobbles bearing Ordovician percussion marks were not identified or recognized from the nearshore or beach deposits of the Habitation Area (Barnett 1991); however, "characteristic cobbles [?with Ordovician percussion marks] from the Mystic Ridge were reported"...from the Habitation Area trench (R.E. Lee, pers. comm.).

Acknowledgements

I am grateful to Dr. Peter Storck, Curator Emeritus, Department of Anthropology, ROM and Dr. Ronald Williamson of Archeological Services Inc. for the opportunity to study the geology of the Sheguiandah Paleoindian site. Peter generously provided logistical and artistic support.

It is a pleasure to acknowledge and thank Joan Burke, Kathy David, Peter Fenton and David Rudkin, Department of Palaeobiology, and Emil Huston, Department of Anthropology, ROM, for their very capable assistance. Kathy David, in particular, went far above the call of duty to revise the figures at a time when new technologies superseded more traditional ways of preparing illustrations. The joy of being at the ROM is almost entirely due to the creative and competent people who make it the remarkable institution that it (still) is.

Finally, I thank Dr. Markes E. Johnson of Williams College, Williamstown, Mass., for permitting me to use the original plates of his article (Johnson and Rong 1989) and Dr. Darrell G.F. Long, Department of Geology, Laurentian University, Sudbury, Ontario, for reviewing the manuscript of this paper.

References

Barnes, C.R. and T.E. Bolton. 1988. The Ordovician-Silurian boundary on Manitoulin Island, Ontario, Canada. *British Museum of Natural History (Geology)* Bulletin 43: 247-253.

Barnes, C.R., P.G. Telford and G.A. Tarrant. 1978. Ordovician and Silurian conodont biostratigraphy, Manitoulin Island and Bruce Peninsula, Ontario. *Michigan Basin Geological Society, Special Papers* 3: 63-71.

Barnett, P.J. 1991. Project Unit 89-54. Geological investigations at the Sheguiandah archaeological site, Sheguiandah, Ontario. *Ontario Geological Survey Miscellaneous Paper*, Summary of Activities 1991: 137-140.

Barnett, P.J., P. Julig and P.L. Storck. 1991. Geological investigations at the Sheguiandah archaeology site, Sheguiandah, Ontario. *Ontario Mines and Minerals Symposium* 1991: 22.

Bennett, G., B.O. Dressler and J.A. Robertson. 1991. The Huronian Supergroup and associated intrusive rocks. Chapter 14, Geology of Ontario. *Ontario Geological Survey, Special Volume 4*(1): 549-591.

Bretsky, P.W. 1969. Central Appalachian Late Ordovician communities. *Geological Society of America, Bulletin* 80(2): 193-212.

Card, K.D. 1976. Geology of the Espanola-Whitefish Falls area, District of Sudbury, Ontario. *Ontario Division of Mines, Geoscience Report* 131: 1-70.

Chapman, L.J. and D.F. Putnam. 1984. *The physiography of southern Ontario*. Ontario Geological Survey, Special Volume 2. Third Edition. 270 pp.

Copper, P. 1971. *Geology of Manitoulin and adjacent islands*. Geological Association of Canada-Mineralogical Association of Canada, Field Trip 8. 37 pp.

Copper, P. 1978. Paleoenvironments and paleocommunities in the Ordovician-Silurian sequence of Manitoulin Island. *Michigan Basin Geological Society, Special Papers* 3: 47-61.

Copper, P. and D.G.F. Long. 1993. *Upper Ordovician-Early Silurian geology of the Manitoulin Island area, Ontario (Caradoc-Llandovery)*. Field Trip Guidebook, Canadian Paleontology Conference, Laurentian University, Sudbury (October 3, 1993), 36 pp.

Corfu, F. and A. Andrews. 1986. A U-Pb age for mineralized Nipissing diabase, Gowganda, Ontario. *Canadian Journal of Earth Sciences* 23: 107-112.

Deller, D.B. 1979. Paleo-Indian reconnaissance in the counties of Lambton and Middlesex, Ontario. *Ontario Archaeology* 32: 3-25.

Eley, B.E. and R.K. Jull. 1982. Chert in the Middle Silurian Fossil Hill Formation of Manitoulin Island, Ontario. *Bulletin of Canadian Petroleum Geology* 30(3): 208-215.

Eley, B.E. and P.H. von Bitter. 1989. *Cherts of southern Ontario*. Royal Ontario Museum Publications in Archaeology. 51 pp.

Fullerton, D.S. 1986. Great Lakes region 14,800 years ago. *Quarterly Science Review* 5: 23-26.

Johnson, M.D. and P.G. Telford. 1985. Paleozoic geology of the Little Current Area, District of Manitoulin. Ontario Geological Survey, Geological Series-Preliminary Map P.2670, Scale 1:50 000.

Johnson, M.E. 1988. Hunting for ancient rocky shores. *Journal of Geological Education* 36: 147-154.

Johnson, M.E. and Jia-Yu Rong. 1989. Middle to Late Ordovician rocky bottoms and rocky shores from the Manitoulin Island area, Ontario. *Canadian Journal of Earth Sciences* 26: 642-653.

Kobluk, D.R. 1984. Coastal paleokarst near the Ordovician-Silurian boundary, Manitoulin Island. *Bulletin of Canadian Petrology and Geology* 32(4): 398-407.

Kobluk, D. 1990. Geology of the Manitoulin area. *University of Toronto Field Camp, Guide Book and Field Manual*, 15 pp.

Lee, T.E. 1957. The antiquity of the Sheguiandah site. *The Canadian Field-Naturalist* 71: 117-137.

Lee, T.E. 1978. Sheguiandah and early Man. *Michigan Basin Geological Society*, Special Papers 3: 87-89.

Lee, T.E. 1983. The antiquity of the Sheguiandah site. *Anthropological Journal of Canada* 21: 46-73 [Reprint of 1957 paper].

Lewis, C.F.M. 1970. Recent uplift of Manitoulin Island, Ontario. *Canadian Journal of Earth Sciences* 7: 665-675.

Liberty, B.A. 1968. Ordovician and Silurian stratigraphy of Manitoulin Island, Ontario. *Michigan Basin Geological Society, Guidebook for 1968 Annual Field Conference*, 25-37.

Liberty, B.A. 1978. Ordovician nomenclature of Manitoulin Island. *Michigan Basin Geological Society, Special Papers* 3: 43-45.

Ontario Division of Mines, Map 2247. 1972. Little Current Area, Manitoulin District. Scale 1:63 360.

Robertson, J.A. 1986. Huronian geology and the Blind River (Elliot Lake) uranium deposits, 7-31, the Pronto Mine. *Canadian Institute of Mining and Metallurgy, Special Paper* 33: 36-43.

Robertson, J.A. 1990. Middle to Late Ordovician rocky bottoms and rocky shores from the Manitoulin Island area, Ontario: Discussion. *Canadian Journal of Earth Sciences* 27: 158.

Robertson, J.A. and K.D. Card. 1972. Geology and scenery, north shore of Lake Huron region. Ontario Division of Mines, *Geological Guide Book 4*, 224 pp. (3rd ed. 1988).

Russell, D.J. and P.G. Telford. 1983. Revisions to the stratigraphy of the Upper Ordovician Collingwood beds of Ontario—a potential oil shale. *Canadian Journal of Earth Sciences* 20: 1780-1790.

Sanford, J.T. 1957. Geologic observations at the Sheguiandah site. *The Canadian Field-Naturalist* 71: 138-148.

Sanford, J.T. 1971. Sheguiandah reviewed. *Anthropological Journal of Canada* 9: 1-15.

Sanford, J.T. 1978. The stratigraphy of the Manitoulin Island area. *Michigan Basin Geological Society, Special Papers* 3: 31-41.

Sanford, J.T. 1983. Geologic observations at the Sheguiandah site. *Anthropological Journal of Canada* 21: 74-87 [Reprint of 1957 paper].

Sanford, J.T. and R.E. Mosher. 1978. Road log, 1978 field trip, Manitoulin Island. *Michigan Basin Geological Society, Special Papers* 3: 3-28.

Sanford, J.T., R.E. Mosher and J.W. Kennedy. 1978. The Ordovician-Silurian boundary. *Michigan Basin Geological Society, Special Papers* 3: 95-99.

Sly, P.G. and C.F.M. Lewis. 1972. *The Great Lakes of Canada—Quaternary geology and limnology*. Excursion A43, Fourteenth International Geological Congress, Montreal. Geological Survey of Canada.

Stanley, S.M. 1989. *Earth and life through time*. New York, W.H. Freeman and Company, second edition, 689 pp.

Stearn, C.W., R.L. Carroll and T.H. Clark. 1979. *Geological Evolution of North America*. Toronto, John Wiley & Sons, third edition, 566 pp.

Stockwell, C.H. 1982. Proposals for time classification and correlation of Precambrian rocks and events in Canada and adjacent areas of the Canadian Shield: part 1—a time classification of Precambrian rocks and events. *Geological Survey of Canada Paper* 80-19: 1-135.

Storck, P.L. and P.H. von Bitter. 1989. The geological age and occurrence of Fossil Hill Formation chert: Implications for Early Paleoindian settlement patterns in southern Ontario and North America. In *Eastern Paleoindian Lithic Resource Use*, edited by C.J. Ellis and J.C. Lothrop, pp. 165-189. Boulder, Colorado: Westview Press.

Thurston, P.C. 1991. Geology of Ontario: Introduction. *Ontario Geological Survey, Special Volume 4*(1): 3-25.

Wright, D.J. and B.R. Rust. 1985. Preliminary report on the stratigraphy and sedimentology of the Bar River Formation. *Ontario Geological Survey, Miscellaneous Paper* 127: 119-123.

Chapter 10

Characterization of Sheguiandah quartzite and other potential sources of quartzarenite artifacts in the Great Lakes region

D.G.F. Long, P.J. Julig and R.G.V. Hancock

Abstract

Quartz rich lithic materials were widely used in the manufacture of stone artifacts by the Paleoindian cultures in the Great Lakes region of North America. Between about 12,000 and 10,000 BP the early Paleoindians used fine grained high-quality cryptocrystalline chert, along with some silicified quartzarenite and minor crystal quartz; from about 10,000 to 7500 BP the late Paleoindian Plano culture commonly used coarser grained materials, including quartzites, silicious quartzarenites and sandstones from selected bedrock quarry sources like those at Sheguiandah and in the Hixton Silicified Sandstone at Silver Mound, Wisconsin. As many non-chert lithic artifacts are visually similar it is necessary to use petrographic and/or geochemical techniques to positively identify source location. Samples derived from sheared rocks of the Bar River Formation in the Paleoindian quarry at Sheguiandah contain trace amounts of red and blue luminescent accessory minerals, while samples from other locations within the Bar River Formation are predominantly non luminescent. Samples from Silver Mound have luminescent rim cements. Samples of the Bar River Formation from the Shequiandah quarry are further characterized by the presence of abundant polycrystalline quartz grains with marked evidence of strain recrystallization into polygonal quartz domains along grain boundaries.

Chemically quartzarenites are over 95% SiO_2 (silica dioxide), however there are some chemical differences between formations used by Paleoindians, which may in turn be used to differentiate the quarries and source artifacts. Comparison of INAA (Instrumental Neutron Activation Analysis) data for archaeological samples with sets of data from geological samples allows a preliminary estimate of provenance to be made for selected Late Paleoindian assemblages.

Résumé

Les cultures paléoindiennes de la région des Grands Lacs d'Amérique du Nord utilisaient largement des matériel lithiques riches en quartz pour fabriquer des artefacts en pierre. De 12 à 10 milles ans avant aujourd'hui, les premiers paléoindiens utilisaient des chert crypto-cristallins de haute qualité à grains fins, ainsi que de l'arénite de quartz silicifiée et secondairement du cristal de quartz. De 10 à 7,2 milles ans avant aujourd'hui, la culture Plano de la fin de la période paléoindienne utilisait couramment des matériaux à grains grossiers, y compris des quartzites, des arénites de quartz siliceux et des grès de sources rocheuses choisies comme celles de

The Sheguiandah Site: archaeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario, edited by P. Julig. Canadian Museum of Civilization, Archaeological Survey of Canada, Mercury Series Paper 161, 2002.

Sheguiandah et de Hixton Silicified Sandstone à Silver Mound (Wisconsin). Étant donné que de nombreux artefacts lithiques non siliceux ont la même apparence, il faut recourir à des techniques pétrographiques ou géochimiques pour identifier avec certitude le lieu de la source. Des échantillons prélevés dans des roches débitées de la formation de la rivière Bar dans la carrière paléoindienne de Sheguiandah contiennent des traces de minéraux secondaires luminescents rouges et bleus, alors que des échantillons prélevés ailleurs dans cette même formation sont surtout non luminescents. Des échantillons de Silver Mound ont des ciments de bordure luminescents. Des échantillons de la formation de la rivière Bar de la carrière de Sheguiandah se caractérisent en outre par la présence d'abondants grains de quartz polycristallins portant la preuve marquée de recristallisation par des quartz polygonaux le long des limites des grains.

Sur le plan chimique, les arénites de quartz sont constituées à plus de 95 % de SiO_2 (dioxyde de silicate), mais il èxiste des différences chimiques entre les formations utilisées par les Paléo-indiens, différences qui peuvent à leur tour être utilisées pour différencier les carrières et les sources des artefacts. La comparaison des données de l'analyse par activation neutronique instrumentale des échantillons archéologiques et de séries de données provenant d'échantillons géologiques permet d'arriver à une estimation préliminaire de la provenance d'assemblages choisis de la fin de la période paléoindienne.

Introduction

One of the most noted characteristics of Paleoindian cultures is their use of high quality, often non-local or exotic cherts, and the similarities of their lithic assemblages across broad regions (Mason 1981, 1986; Goodyear 1989). In the Great Lakes region of North America quartz rich lithic materials were widely used in the manufacture of stone artifacts by Paleoindian cultures. The Early Palaeoindian (ca. 12,000 - 10,000 BP) fluted-point people used mainly cryptocrystalline chert (Goodyear 1989), while the Late Paleoindian Plano culture (ca. 10,000 - 7500 BP) commonly used coarser grained materials, including quartzite (crystalline material), silicious quartzarenite (sandstone), taconite (banded iron formation and ferruginous chert) and siltstone from bedrock quarry sources (Julig 1991, 1994; Julig and McAndrews 1993, Julig *et al.* 1998a, 1998b). At many Late Paleoindian sites non-cryptocrystalline lithics form over 95% of artifact assemblages (Clark 1989; Buckmaster 1989; Julig 1994). Expedient tools may be made from lower quality local materials (Julig *et al.* 1989), while curated tools and assemblages appear to be more commonly made from higher quality lithic materials, such as those found at Sheguiandah (Bar River Formation) and Silver Mound (Hixton Silicified Sandstone); which are superficially similar white fine grained silicified quartzarenites.

In many studies non-local lithic materials are often reported as "exotic", or assigned to specific sources using "expert analysis" involving visual comparison of colour, texture and fracture characteristics of artifacts. While this can be quite successful, complications arise as many of the quartzites and sandstones of the Great Lakes region are visually similar (Julig *et al.* 1998a, 1998b). It is apparent that even among knowledgeable archaeologists basic lithic material identification is subject to a 30-70% error rate (Calogero 1992; Church 1996).

In this paper we use the terms quartzite sandstone (which breaks across rather than between sand grains) and silicified quartzarenite silica cemented sandstone (with more than 95% quartz sand grains) interchangeably, as nearly all of the samples examined meet both criteria. We use standard petrographic analysis to characterize potential sources using debitage from archeological sites and geological samples from several major quarry sources in the Great Lakes Region, including the Lorrain, Bar River and Mesnard Formations, and the Ajibik Quartzite and Hixton Silicified Sandstone. As this method involves partial destruction of artifacts, we also presents results of cathodoluminescence (CL) microscopy and chemical data from instrumental neutron activation analysis (INAA) which can in some cases be used to differentiate artifact sources. These techniques have the advantage that they can be applied non-destructively and artifacts can be returned with no damage. Preliminary results of this study, including discussion of the use of x-ray florescence analysis have been published elsewhere (Julig *et al.* 1998a, 1998b).

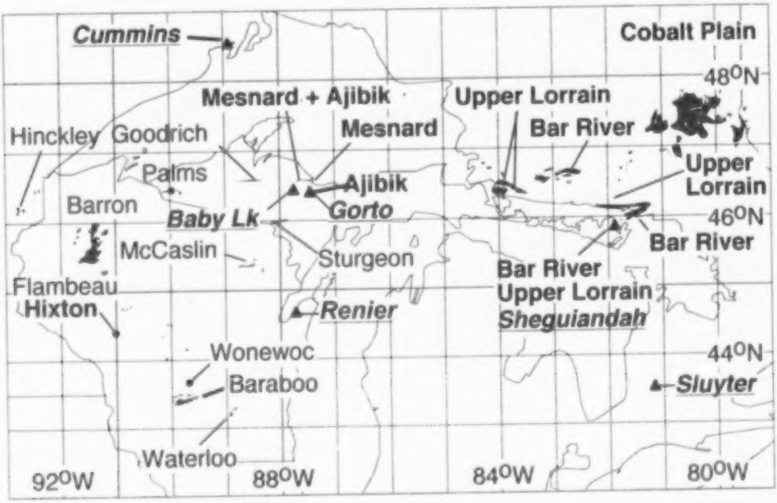

Cummins
Cobalt Plain
48°N
Mesnard + Ajibik
Upper Lorrain
Hinckley
Goodrich
Mesnard
Bar River
Palms
Ajibik
Upper Lorrain
Barron
Baby Lk
Gorto
46°N
McCaslin
Sturgeon
Bar River
Flambeau
Bar River
Hixton
Upper Lorrain
Renier
Sheguiandah
Wonewoc
44°N
Baraboo
Sluyter
Waterloo
92°W
88°W
84°W
80°W

Figure 10.1. Quartzarenites (black) in the Upper Great Lakes region of Canada and United States. Triangles represent sites from which Late Paleoindian artifacts were examined for this study (archaeological site names in italics).

Quartzites of the Great Lakes region

Although the Paleoindian quarries at Sheguiandah were a source of certain sandstone artifacts found in the Great Lakes Region, superficially similar quartzite material is known from several other localities in the Great Lakes Region (Figure 10.1) and may have been traded or exchanged between groups. Quartzite (metamorphosed quartz-rich rock, which breaks across mineral grains) and siliceous quartzarenite (undeformed quartz rich sandstone with >95% quartz grains, and a quartz cement) typically occur as prominent positive landscape features due to their enhanced resistance to weathering (see von Bitter, this volume). Major sources include the Early Paleoproterozoic (2.2-2.4 Ga) Huronian Super Group of Northern Ontario and its equivalents in the Marquette Supergroup of Michigan and Wisconsin (Lorrain, Mesnard, Sturgeon and Bar River Formations); the Late Paleoproterozoic (2.1-1.9 Ga) Animikie Group on the South and west of Lake Superior (Pokegama, Sunday and Ajibik Quartzites, Manhomen, Felch and Goodrich Formations); Late Paleoproterozoic and Mesoproterozoic (1,450-1750 Ma) (red) sandstones of the Baraboo, Sioux and Barron Formations; and Late Cambrian silicified quartzarenites of the Dolgellian (510-514 Ma) Wonewoc Formation, otherwise known as the Hixton Silicified Sandstone. Many of the above sandstones, and artifacts manufactured from them are superficially similar. As many of these units have broad areas of exposure (Figure 10.1) it is necessary to determine the specific characteristics of individual quarry sites if this information is to be of use to archaeologists attempting to model cultural interactions and trade patterns.

Early Proterozoic Quartzites at Sheguiandah

Paleoindians extensively quarried lithic material from the Bar River Formation at Sheguiandah, Lumsden Lake, and George Lake Site (Figure 10.2 a-d). Strata of the Early Paleoproterozoic Bar River Formation underlie a prominent 33 km long range of hills within Killarney Provincial Park and are exposed in a belt of islands in Lake Huron which extends 40 km SSW of Killarney, towards Sheguiandah on Manitoulin Island (Figure 10.1; Card 1978). The crests of these hills would have been exposed, and probably surrounded by water at 10,000 BP, but were accessible before 9500 BP (see Barnett; Anderson and Lewis, this volume). Further to the NE minor exposures are present in the Cobalt Plane between Smoothwater and Lady Evelyn Lakes (Card *et al.* 1973), and in and about Welcome Lake (Long and Colvine 1985, 1986). These may have been covered by ice during Late Paleoindian times. Low relief exposures of the formation are also present in three small areas near Sault Ste Marie (Frarey 1977) and in the Flack Lake area (including Mississagi Provincial Park), 15 km north of Elliot Lake (Wood 1973; Wright 1985; Rust and Shields 1986).

The Bar River Formation is up to 900 m thick; it is dominated by white, and to a lesser extent pink, well sorted fine to medium sandstone with >98% quartz (Hewitt 1963; Turek and MacGregor 1984; McAuley 1996). The strata are superficially similar to the upper part of the Lorrain Formation (see below). Most sand grains in the Bar River Formation samples are rounded to well rounded. In northern areas the siliceous cements, where present, show little to no sign of post burial strain (uneven extinction), while those in the south have been more severely deformed, and show abundant evidence of strain (Figure 10.3d). Minor components include muscovite and hematite.

Samples of the Bar River Formation were collected from the Sheguiandah archaeological site (45°53'51"N, 81°55'19"W), where the quartzite has a pronounced cleavage and an excellent conchoidal fracture (Figure 10.2a-b). Other samples were collected from outcrops 1 to 5 km north and west of the Sheguiandah quarry site, where strata break into rhombs along joints at spacings of 5 to 45 cm, with a sub-conchoidal fracture (Figure 10.2c). Additional moderately strained samples were collected from the Lumsden Lake (George Lake) archaeological site in Killarney Park (46°01'35"N, 81°26'05"W: Figure 10.2d) included one feldspathic sample. Unstrained samples of the formation were collected in the vicinity of Mississagi Provincial Park (46°32'N, 82°48'W).

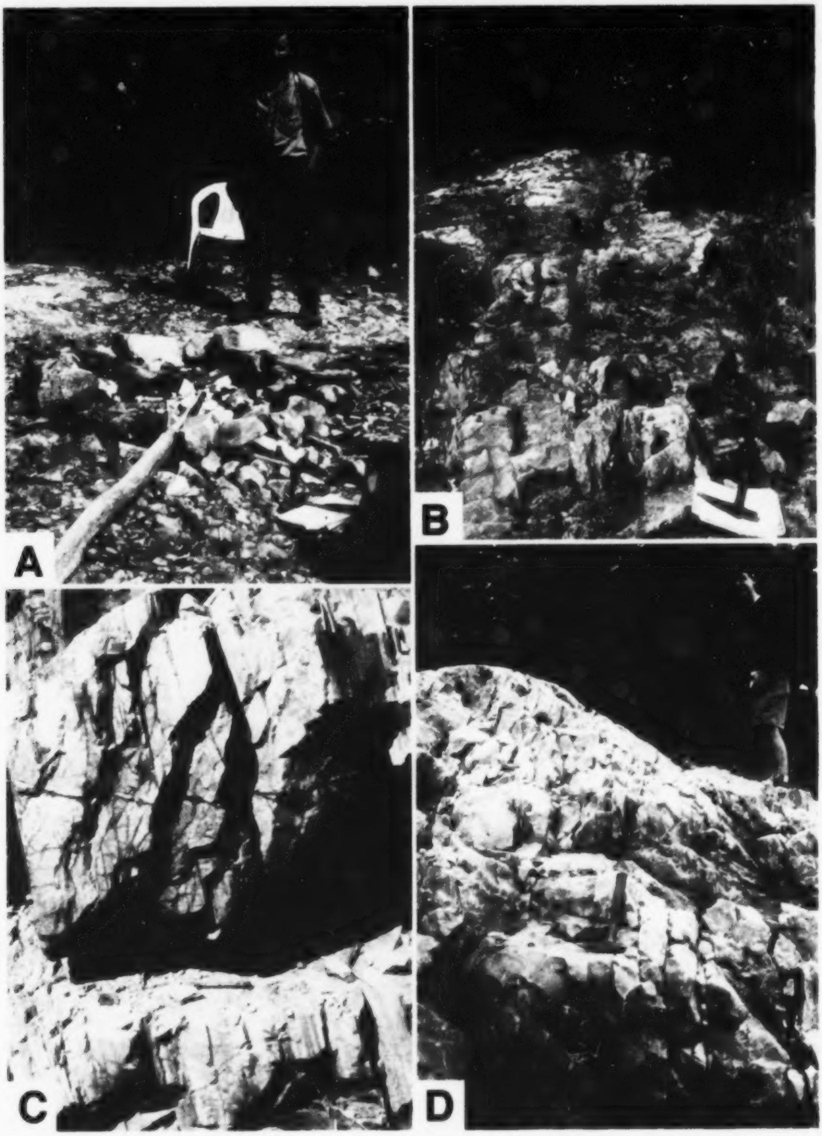


Figure 10.2. Exposures of the Bar River Formation at archaeological Sites. A: Pat Julig observes abundant debitage beneath recent fire-pit at the top of the crest of the Sheguiandah site. B: Exposure of the Bar River Formation at Sheguiandah showing closely spaced joints which may have facilitated extraction of core material. C: Bar River Formation exposed near the Sheguiandah Museum – material is less recrystallised and has more irregular joints than at the Sheguiandah site. D: Closely spaced joints in the Bar River Formation at the Lumsden Lake site in Killarney Provincial Park. Joint spacing may have facilitated mining which is less evident than at the Sheguiandah site.

Other Early Paleoproterozoic Quartzites

Strata of the Early Paleoproterozoic Lorrain Formation is exposed in a 250 km long series of hills between Sault St. Marie and Killarney National Park, along the northern margin of Lake Huron, Ontario, as well as in numerous ridges across the Cobalt Plain, 25-100 km north of Lake Huron (Figure 10.1). The Formation, which is between 1.5 and 2.4 km thick (Hadley 1968), was metamorphosed during the Penokean Orogeny (Young *et al.* 2001), includes silicified quartzarenite, subarkose and arkose (Folk 1980). Quartzarenites which are superficially similar too, and have been confused with, sandstones of the Bar River Formation at Sheguiandah are most common in the upper third of the formation (Lowey and Long 1985).

Samples collected from the Willisville area (46°07'41"N, 81°44'08"W), in the LaCloche Mountains, south of Espanola Ontario, are from the upper member of the formation, which is dominated by sheared, white well sorted medium to very fine sandstones with >98% quartz (Hewitt 1963; McAuley 1996). At this locality the formation is dominated by massive and trough cross stratified medium to fine sandstones, which break with a sub-conchoidal fracture. Major joints are spaced at 1 to 1.5 m apart hence weathered blocks may have been too large for transport over extended distances. Samples of the upper member from Burnett's Side Road, near Sheguiandah (45°54'27"N, 81°56'53"W) are predominantly medium to coarse sand grade, and break, with an irregular hackley fracture into irregular polygonal blocks along master joints at 20 to 40 cm apart. Additional samples were collected from the upper member at Rydal Bank (46°22'06"N, 83°43'38"W) and Gordon Lake (46°24'14"N, 83°49'27"W) near Sault St. Marie, where the formation is significantly less deformed (Frarey 1977). At both these localities the strata broke with a hackley, rather than conchoidal fracture, and the majority of samples would not have been suitable for artifact production. Major sub-vertical joints were 5-10 cm apart, with bedding plane joints at 30 to 120 cm.

The Mesnard Formation in the Marquette Range in Michigan is a lateral equivalent of the Lorrain Formation in Ontario as well as the Sturgeon Quartzite in Dickinson County, Michigan (Young 1983). Larue (1981a) notes that the quartzites are between 50 and 600 m thick, and consist predominantly of medium to fine sandstone, with >95% quartz. Like parts of the Lorrain Formation they contain small but significant proportions of potassium feldspar, and typically have a matrix containing abundant white mica. While samples examined by Larue (1981a) were dominated by monocrystalline quartz grains, evidence of straining may be ubiquitous, as locally these quartzites have been metamorphosed at biotite to staurolite grade. Chert is present as a minor constituent. Samples of the Mesnard Formation used in this study were collected from the quarry at the east end of Mt Mesnard (46°30'12"N, 87°21'44"W) opposite the Harvey Welcome Centre in Michigan, and from Naganee (46°30'59"N, 87°36'02"W). Stratigraphically equivalent strata (James *et al.* 1961; Young 1983) of the Sturgeon Quartzite were sampled near Randville, Wisconsin (45°59'19"N, 88°03'19"W). According to Clark (1989) these Mesnard quartzites may have been used by Late Paleoindian groups in the upper Michigan region.

Late Paleoproterozoic Sandstones

The Late Paleoproterozoic (2.1-1.9 Ga) Ajibik Quartzite outcrops as a unit, up to 200 m thick, in an 50 km belt within the Marquette Range of Northern Michigan (Puffett 1974). It represents the basal part of the Menominee Group, which has been correlated with the basal part of the Animikie Group in the Gunflint Range of N.W. Minnesota and N.W. Ontario. Correlative quartz-rich sandstone units include 20-50 m of quartzite in the upper part of the Palms Formation (Gogebic Range, NW Michigan and N Wisconsin) and Pokegama Quartzite (Mesabi Range, Minnesota); parts of the Mahnomen Formation (Cuyuna Range, Minnesota), and 1-3 m of the Felch Formation (NW Michigan: Larue 1981b; Ojakangas 1983; Young 1983). Typically resistant weathering sandstones in these units are fine to medium grained, with <2% matrix, 60-90% detrital quartz (monocrystalline, with subordinate polycrystalline and chert: Fig 10.3c), 0-15% detrital potassium feldspar and plagioclase (approximately 2:1 ratio) and 0-15% mica (Larue 1981 b). Less resistant sandstone beds may contain 1-30% quartz-sericite matrix. Samples collected for this study were from a ridge extending NW from Deer Lake (46°29'43"N, 87°31'41"W), near the Gorto site of Buckmaster and Paquette (1988) and Buckmaster (1989), and from Naganee (46°30'59"N, 87°36'02"W) where the formation unconformably overlies the Mesnard Formation. In places the material can appear similar to Cambrian Sandstones, such as the Hixton Silicified Sandstone (Wonewoc Formation) at Silver Mound.

The Goodrich Quartzite was sampled near the Sturgeon River Rapids (46°37'24"N, 88°28'31"W), south of Alberta, Michigan. This unit is stratigraphicaly younger than the above formations, and forms the basal part of the Baraga Group in the Marquette Range (Ojakangas 1983). The unit is generally poorly exposed and does not form prominent ridges. At Sturgeon River Rapids the formation is dominated by ripple laminated sandstones which occur in beds 5-10 cm thick. It has a high mica content, and breaks with an irregular fracture and as such is unlikely to have been widely used in the production of lithic artifacts.

Late Paleo- to Meso-proterozoic (Red) Sandstones

The McCaslin Formation (Olson 1982) was sampled at Quartz Mountain (45°22'28"N, 88°37'59"W) and along the Deer Lake lookout trail (45°25'11"N, 88°27'33"W). The formation is between 610 and 1200 m thick, and is dominated by light red (white to brick red) massive, planar and trough cross-stratified, medium and coarse grained quartzarenites. These are similar to correlative strata in the Sioux, Flambeau, Barron, Baraboo, and Waterloo Formations (Dott and Dalziel 1972; Olson 1982).

A petrographic study of 70 samples by Olsen (1982) showed that most samples are dominated by quartz, with minor sericite kaolinite and haematite. Heavy minerals are dominated by zircon, with minor red rutile, blue tourmaline, haematite and pyrite. Metamorphic minerals include pink to colourless andalusite which is commonly altered to sericite. Sillimanite and epidote are present locally. While red Hixton samples may appear superficially similar to parts of the McCaslin Formation, the latter does not tend to be suitable for artifact production as it is too coarse grained.

The Baraboo Quartzite consists of predominantly pink to purple coloured silicified quartzarenites which occur in southern Wisconsin (Dott 1983; Dalziel and Dott 1970; Laberge *et al.* 1992). The formation was sampled on the south (43°23'35"N, 89°46'12"W) and north (43°25'54"N, 89°46'30"W) side of the Baraboo range, and at Rock Springs (43°29'21"N, 89°54'58"W). Equivalent strata of the Waterloo Quartzite (Buell, 1892; Geiger 1982) were sampled in a quarry near Portland, Wisconsin (43°14'N, 88°04'30"W). They appeared to break into large blocks (>50 cm) with irregular fractures and are not ideal for artifact manufacture.

Neoproterozoic Sandstones

Samples of the Neoproterozoic Hinckley Sandstone (Upper Kewanawan: equivalent to the Jacobsville Sandstone at the east end of Lake Superior (Tryhorn and Ojakangas 1972), were collected from the Banning Quarry (46°09'41"N, 92°50'59"W), and Sandstone Park (46°08'03"N, 92°51'34"W) at Sandstone, Minnesota. Petrographic studies by Tryhorn and Ojakangas (1972) indicate that detrital grains in the samples average 94% quartz and 2% feldspar, opaque minerals and volcanic rock fragments are common (2% each). All samples examined were highly friable and generally unsuitable for high-quality artifact production.

Cambrian Sandstones

The Hixton Quartzite (Tankersley 1988), also known as the Hixton Silicified Sandstone (HSS) (Porter 1961), the Silver Hill Quartzite and Silver Mound Quartzite, is one of several quartzarenite units of late Cambrian age which occur near the base of the Paleozoic succession in Michigan, Wisconsin and Minnesota in the south western part of the study area (Anstett 1977; Becker 1931; Dott 1973, 1974; Ostrom 1987a, 1987b; Wanenmacher 1932). Most of these sandstones are very poorly cemented and would have been too friable to produce useable stone tools. Lindenberg (1996), following Klemic and Ohlson (1983) placed silicified sandstones at Silver Mound within the Wonewoc Formation. Klemic and Ohlson (1983) suggest that the local development of silica cements in the Wonewoc Formation at Silver Mound were formed during weathering of the overlying Lone Rock Formation (now removed). A similar origin has been suggested for silica cemented horizons in the Jordan Formation (Trempealeau Group) of the Baraboo district by Dalziel and Dott (1970). While the extensive Paleoindian quarrying and utilization of Hixton silicified sandstone at Silver Mound has been well documented, evidence of quarrying of other macroscopically similar horizons within Cambrian strata of Wisconsin have also been demonstrated at "Arcadia Ridge" in Trempealeau County, and other sites in Buffalo, Trempealeau, Monro, Jackson and LaCrosse counties (Boszhardt 1994; Lindenberg 1996). Samples of debitage from the Acadia Ridge, Manke Farm, Wallah Wontor, Four Corners, and the Symstad site were provided by Boszhardt.

Samples of the Hixton Silicified Sandstone examined in this study (see also Julig *et al.* 1998a) included donated material from Caven P. Clark and Jack Holland, and loose samples from the garden of the KOA campsite at Silver Mound, Alma Centre, Jackson County, west central Wisconsin (44°25'29"N, 90°57'13"W). Previous reports indicate that this unit is unusual in that it is especially well cemented by opaline silica, and has a distinctive oxygen isotope signature (Porter 1961; Ebright 1987; Tankersley *et al.* 1988; Tankersley 1988, 1989; Bakken 1995).

Behm and Faulkner (1974) have noted that controlled heating of the Hixton Quartzite induces colour changes at temperatures as low as 245°C due to transformation of light to darker coloured iron oxides. The lighter and non-heat treated sample of Hixton can be visually similar to other quartzites across the region, including Lorrain and Killarney materials.

Petrographic Analysis

Standard petrographic analysis of geological specimens involves preparation of a 30 micron thick slice of rock, mounted in epoxy on a glass slide. This is followed by systematic identification and counting of detrital sand grains (framework components), detrital matrix (mud and clay trapped between the sand at the time of deposition), voids (spaces between grains) and cements (minerals introduced into spaces between sand grains during burial and consolidation). In this study a minimum of 500 framework grains were counted using a fixed interval moving stage. Uncovered thin sections (cover-slip temporarily attached with water) were used so that the same samples could be examined using cathodoluminescence techniques (see below) and stained if necessary.

Results of petrographic analysis of the geological material are presented in Table 10.1, and Figure 10.4. In these data sets the abundance of framework quartz, feldspar, and lithic grains (Q, F, and L) has been recalculated to equal 100%, while the matrix, cements and voids are given as a percentage of the whole rock. Quartz is the dominant mineral in thin sections, both as detrital grains and cement. As the variety of quartz can be of use in determining the provenance of the samples, the ratio of unstrained (Qm), polycrystalline (Qp) and strained (Qs) quartz were examined (Figure 10.4), as was the abundance of chert (Qc). Detrital feldspars are rare in all samples examined. Potassium feldspar (Fk) was detected in minor amounts in some samples from the Ajibik, Sturgeon and Mesnard Formations and the Baraboo and Hinkley Sandstones. It is present in samples from the Upper member of the Lorrain formation near Rydal bank, but not in areas to the south. Microcline (Fm) was present only in samples from the Sturgeon Formation. Plagioclase (Fp) was not detected.

Fine grained patches of white mica form a substantial part of samples from the Goodrich Formation, and occur in samples of the Ajibik from Naganee, the Sturgeon, Lorrain, Mesnard and McCaslin Formations, and the Baraboo Quartzite (Figure 10.3a). This fine grained micaceous material is interpreted as epimatrix (Fe) formed by in situ decomposition of feldspars during diagenesis and metamorphism and is not found in samples from the Sheguiandah quarry. Chert grains (Figure 10.3c) are present in most samples from the Ajibik, Mesnard, Baraboo and Hinkley. Samples of the upper Lorrain from Rydal Bank contained chert grains, but these were not encountered in samples of the same formation in areas to the south. Chert was detected in only one sample of the Hixton Silicified Sandstone. Detrital grains of older mudrocks (Ls = Lithic, sedimentary) were detected in samples of the Ajibik from Naganee and the Mesnard from Naganee and Mt Mesnard. Volcanic rock fragments (Lv) are present in samples from the Baraboo Quartzite (this study and Hendry 1975). Metamorphic rock fragments (Lm) were not detected. Exotic metamorphic minerals, including diaspore and andalusite are present in some of the older sandstone units, but are never abundant or ubiquitous.

As can be seen in Table 10.1 and Figure 10.4, there is little to distinguish many of the geological sources examined, based on their bulk petrography, as all sample contain abundant detrital quartz, and plot (Figure 10.4) as quartzarenites (>95% of framework grains are quartz). Samples from the Baraboo include quartzarenites, sub-arkose and arkose, while those from the Goodrich are all arkosic arenites. Detrital matrix forms a significant proportion of samples from the Mesnard, Lorrain, McCaslin, Bar River, Ajibik and Baraboo.

Figure 10.3 (opposite). Polarized Thin sections and CL Features.

A. Typical polarized thin section of the Upper member of the Lorrain Formation in the Rydal Bank area (Field of view 15 mm). Note the large patches of white mica, here interpreted as epimatrix (altered feldspar grains). Concavo convex grain boundaries are prominent, with little to no quartz cement. Strained quartz grains show uneven hourglass extinction (lower right), while unstrained grains have even extinction (uniform colour). Dark lines in large quartz grain are related to minor strain following lithification of the quartzarenite.

B. Same unit from near Willisville, note reduce matrix component and polygonized grain boundaries.

C. Polarized thin section of the Ajibik Formation, from near Goose Lake. Note prominent chert grain and dominance of unstrained quartz. Grains were pushed together to produce concavo-convex contacts during formation of a quartz cement in pre-existing pores.

D. Extensive polymerization of quartz grains in sandstone from the Bar River Formation at Sheguiandah. The ragged grain boundaries a product of metamorphic recrystallisation of previously highly strained quartz grains at elevated temperatures.

E. Chalcedonic rim cements and open pores in the Hixton Silicified Sandstone from Silver Mound (in partly crossed polars). Field of view 5 mm.

F. Thin section of Hixton Silicified Sandstone in CL. Note the blue CL colours of some quartz grains, and the multi-layered character of CL in the chalcedonic rim-cements.

G. H. Surface of Hixton artifacts in CL. Note that quartz grains have both bright blue and dull red emission colours and that bright red chalcedonic rim cements are clearly defined despite the rough character of the surface.

In plots of the ratio of detrital quartz types (Figure 10.5), the Hixton Silicified Sandstone can be clearly differentiated from older sandstones on the basis of the high abundance of unstrained quartz grains. These plots may be of lesser use in distinguishing the Hixton from other local silicified Cambrian sandstones in SE Wisconsin. Sample from the Baraboo Quartzite are dominated by strained detrital quartz grains with sutured grain to grain contacts, while other formations show a mixture of quartz types (Figure 10.4). Samples of the Bar River Formation from Sheguiandah can be clearly distinguished from other formations, and from other areas where the same formation is exposed, by the abundance of polycrystalline grains. These are largely a result of strain recrystallisation into polygonal quartz domains along grain boundaries (Figure 10.3d). Differences in the relative abundance of strained and unstrained grains in samples of the same formations in different locations (i.e. Ajibik and Mesnard) may also be related to deformation of quartz grains in situ, reflecting different intensities of tectonism at different sites.

Cement characteristics can also be used to differentiate the various geological sources. Cements are rare in samples from the Bar River, Goodrich and McCaslin Formations, but are conspicuous in all other units. The most common cement is common quartz (as optical overgrowths). Only the Hixton and Ajibik samples contain abundant cement (Table 10.1), as the others have a more compact framework with sutured or concavo convex contacts between grains.

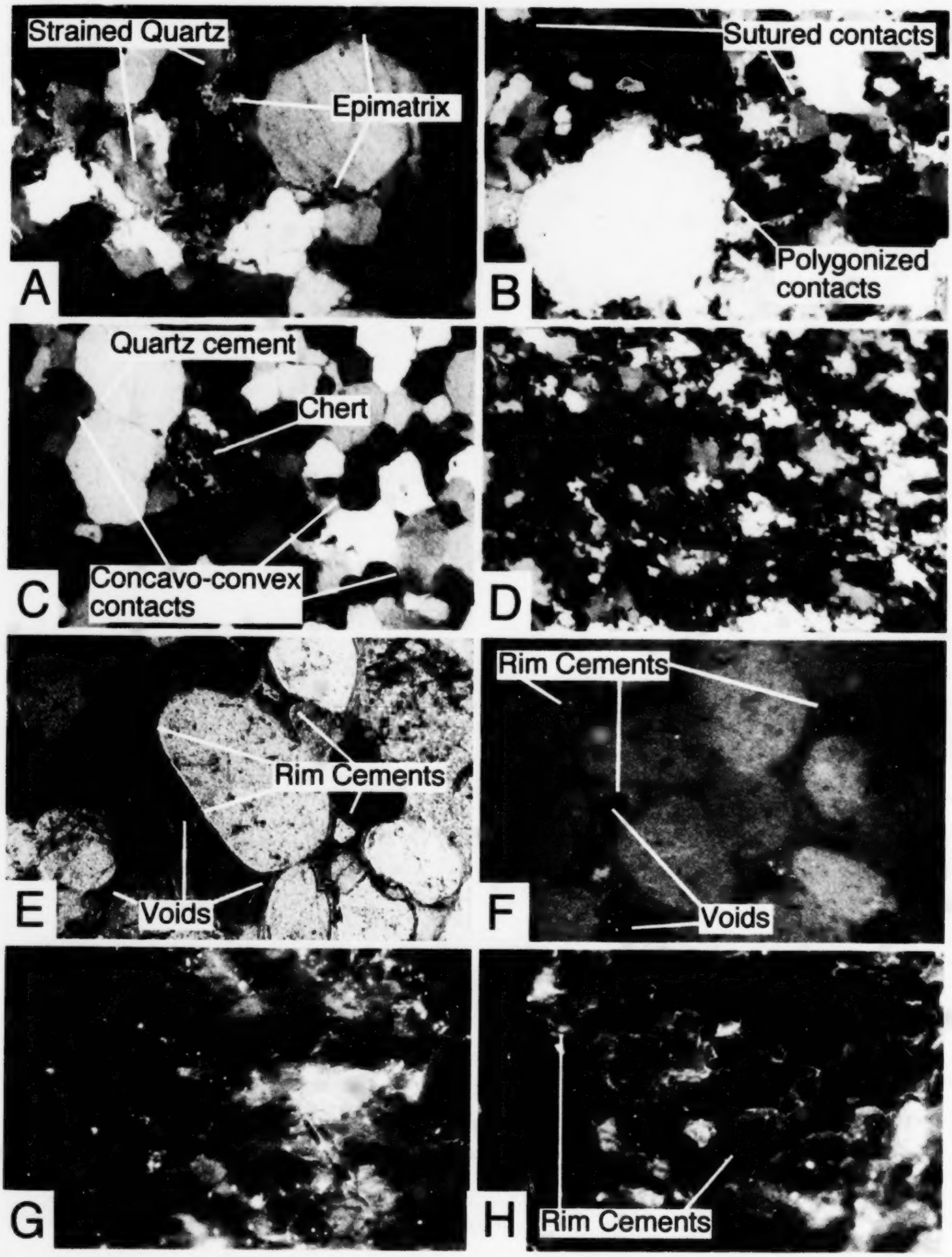

Strained Quartz
Epimatrix
A
Sutured contacts
Polygonized contacts
B
Quartz cement
Chert
Concavo-convex contacts
C
D
Rim Cements
Voids
E
Rim Cements
Voids
F
G
H
Rim Cements

Table 10.1. Petrographic analysis of quartzites from the Great Lakes region.

	Percent of framework grains											Percent of whole rock					
No. of Slides	Qm	Qp	Qs	Qc	Fk	Fp	Fm	Fe	Ls	Lm	Lv	Voids	Matrix	Fe Oxides	Quartz Cement	Chalcedony Cement	N
Cambrian: Wonewoc Formation (Hixton Silicified Sandstone)																	
7	91.2	1.1	7.6	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	1.6	0.0	0.2	1.6	14.9	733
Mesoproterozoic: Hinkley Sandstone																	
4	61.7	1.8	34.7	1.4	0.3	0.0	0.0	0.0	0.1	0.0	0.0	22.8	0.0	0.9	5.2	0.0	985
Late Paleoproterozoic-Mesoproterozoic: Baraboo Formation																	
43	4.1	3.6	71.5	4.5	0.0	0.0	0.0	16.0	0.0	0.0	0.2	0.0	0.8	1.7	11.8	0.0	624
Late Paleoproterozoic (2.1-1.9 Ga): McCaslin Formation																	
4	74.5	0.1	17.9	0.0	0.0	0.0	0.0	7.5	0.0	0.0	0.2	0.0	4.9	0.0	0.0	0.0	737
Late Paleoproterozoic: Agibik Quartzite, Deer Lake, near Gorto site																	
9	51.1	2.8	45.7	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	35.2	0.9	8.6	0.0	730
Late Paleoproterozoic: Agibik Quartzite, Naganee																	
5	25.2	6.8	86.5	0.4	0.1	0.0	0.0	0.6	0.3	0.0	0.0	0.0	53.8	0.0	54.2	0.0	807
Late Paleoproterozoic: Gooderich Quartzite																	
4	42.3	2.4	18.0	0.0	0.0	0.0	0.0	37.4	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	1047
Early Paleoproterozoic (2.2-2.4 Ga): Bar River Formation, Sheguiandah archaeological site																	
5	0.1	53.8	46.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.2	0.0	0.0	0.0	719
Early Paleoproterozoic: Bar River Formation, other parts of Manitoulin Island																	
12	30.6	11.6	57.6	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	7.7	0.0	0.1	0.0	754
Early Paleoproterozoic: Bar River Formation, Killarney Provincial Park, Lumsden Lake site																	
2	17.6	1.8	80.4	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.9	4.0	0.0	0.0	0.0	505
Early Paleoproterozoic: Mesnard Formation, Mount Mesnard																	
10	26.0	6.3	67.0	0.2	0.1	0.0	0.0	0.2	0.2	0.0	0.0	0.0	6.6	0.2	2.4	0.0	749
Early Paleoproterozoic: Mesnard Formation, Naganee																	
9	20.7	7.0	70.7	0.7	0.2	0.0	0.0	0.3	0.2	0.0	0.0	0.0	8.1	0.0	2.9	0.0	786
Early Paleoproterozoic: Mesnard Formation, Sturgeon Quartzite, Randville																	
3	26.5	10.9	61.4	0.0	0.3	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	721
Early Paleoproterozoic: Lorrain Formation, Upper Member, Barnetts Side Road, Sheguiandah Hill																	
3	37.4	16.8	45.4	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	671
Early Paleoproterozoic: Lorrain Formation, Upper Member, Willisville																	
10	21.5	14.1	62.5	0.0	0.3	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	739
Early Paleoproterozoic: Lorrain Formation, Upper Member, Rydal Bank																	
10	58.1	2.3	37.9	0.1	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.2	0.0	1.7	0.0	840

Qm , Qp, Qs = monocrystalline, polycrystalline and strained quartz; Qc = chert; Fk = potassium feldspar; Fp = plagioclase; Fm = microcline; Fe = epimatrix; Ls = sedimentary rock fragments; Lm = metamorphic rock fragments; Lv = volcanic rock fragments; N = average number of points counted on each slide.

The cements in the Hixton are highly diagnostic as they consist of early chalcedonic rim cements, with unstrained quartz infilling residual pores (Figure 10.3e; Porter 1961; Lindenberg 1996). Unfortunately in some localities in SW Wisconsin other silicified Cambrian sandstones have similar cements (Boszhardt 1994), hence the optical properties of the cements alone cannot be used for site specific identification.

Cathodoluminescence

As petrographic methods involve partial destruction of the sample to produce thin sections, the cathodoluminescence characteristics of the uncoated, uncovered surface of the thin sections, untreated rock fragments and untreated lithic artifact debitage, were examined to determine the potential of this method for non-destructive analysis of artifacts. Cathodoluminescence (CL) is a variety of photoluminescence in which minerals emit visible light in response to excitation of an uncoated sample by an electron beam (Marshall 1988; Barker and Kopp 1991). Common minerals exhibiting CL include diamond, zircon, spinel, corundum, ruby, sapphire, cassiterite, calcite, aragonite, dolomite, barite, some hematite, gypsum, anhydite, quartz, garnet and sphene (Marshall 1988). Under CL many quartz grains may emit weak red, blue, violet, rust and brown colours (Marshall 1988); kaolin and some feldspars appear bright blue (Barker and Kopp 1991), while micas may be blue or greenish purple. Devitrified volcanic glasses may appear speckled blue due to formation of feldspar microlites. Phenocrysts of feldspar in rhyolites may also appear as bright blue patches.

Samples from the Early Paleoproterozoic Lorrain and Bar River Formations and the Late Paleoproterozoic McCaslin Formation are predominantly non-luminescent, although trace amounts of red and blue luminescent accessory minerals are present in samples of the Bar River Formation from Sheguiandah. Samples of the Lorrain from Rydal Bank as well as samples from the Baraboo Quartzite show dull red and dull blue luminosity, which tends to fade with exposure to the X-ray beam. Samples from the Mesnard Formation contain 30 to 40% blue luminescent quartz, while those from the Hinkley Sandstone are dominated by dull red luminescent quartz, with 20-30% blue luminescent quartz. Samples of the Late Paleoproterozoic Ajibik quartzite exhibits a uniform (weak) dull red luminescence, which may have developed during metamorphism. Quartz grains in the Goodrich Formation are non-luminescent, although marked bright red luminescence is evident in the epimatrix, presumably due to the presence of carbonate.

Samples from the Hixton Silicified Sandstone contain a mixture of 20-40% of light blue and 40-60% dull red-brown luminescent quartz grains. In addition the initial chalcedonic rim cements are non-luminescent, while the late pore-fill and rim cements have dull red luminescence characteristics (Figure 10.3f). The red-luminescent rims are clearly displayed on the surface of un-treated artifacts and lithologic samples (Figure 10.3g, h) hence these can readily be distinguished from Sheguiandah samples. Samples of petrographically similar silicified Cambrian sandstones from Acadia Ridge, Manke Farm, Wallah Wontor and the Four Corners sites in Wisconsin (Boszhardt 1994) lack a luminescent cement. Samples of the "Alma Quartzite" from the Symstad site and samples from the Four Corners site in SE Wisconsin had local, thin (0.025 mm) in part discontinuous red-luminescent rim cements (half the thickness of Hixton rim cements).

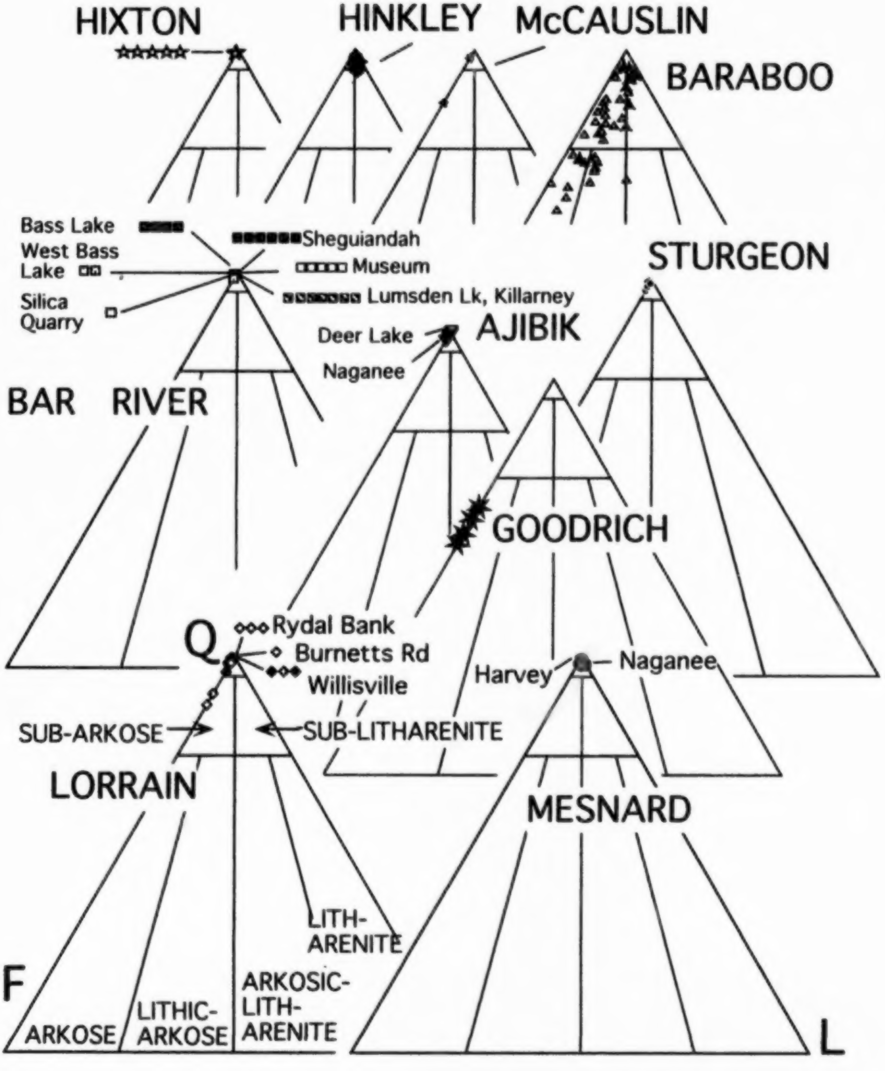


Figure 10.4. Ternary Plots of the ratio of Quartz (including chert) (Q), Feldspar (F) and Lithic (L) components of sand grains in geological Quartzite samples (Cement and matrix components are not included in these plots).

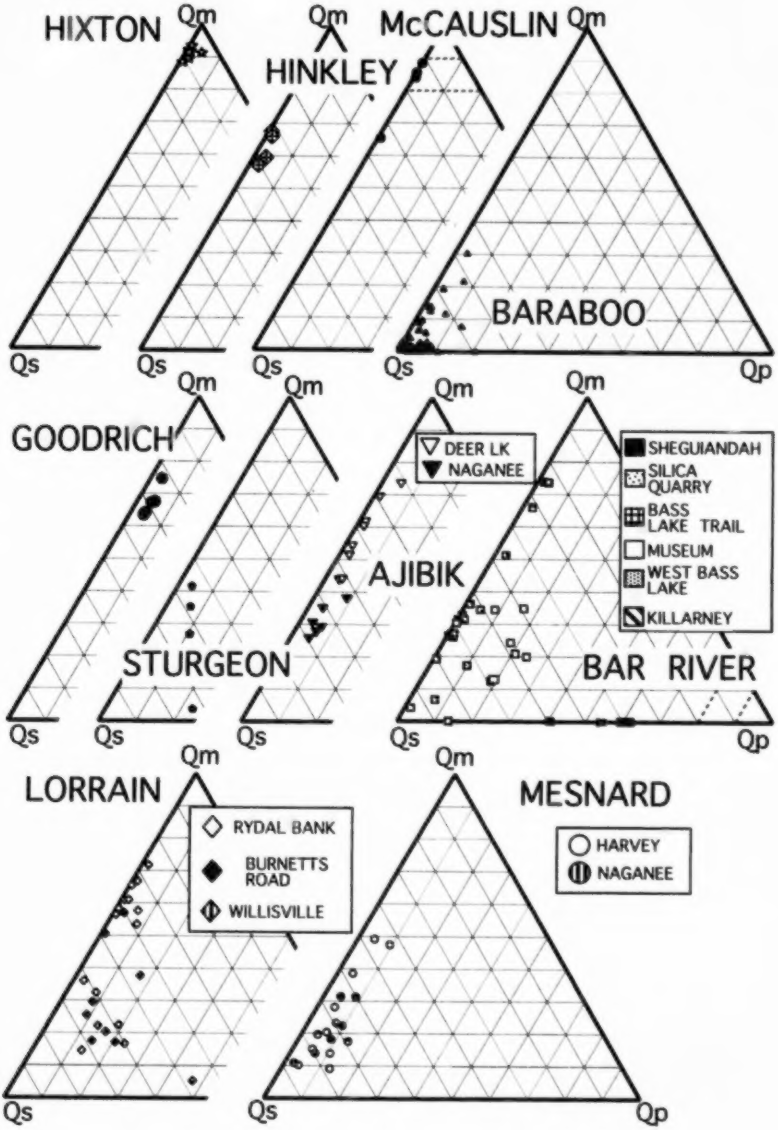


Figure 10.5. Ternary plots of the ratio of monocrystalline (Qm) to polycrystalline (Qp) and strained (Qs) quartz grains in geological quartzite samples.

Chemistry

X-ray fluorescence (XRF) analysis was undertaken on the above geological quartzite sources in order to determine the 10 major elements (oxides) and 14 selected trace elements. Major elements were determined from glass disc method (Table 10.2), using 0.4 g of material. Elemental XRF analyses, using this method, show that most samples are typical quartzites, containing from 83 to 99% silica dioxide: other variables are most closely linked to phyllosilicate (clay/mica) abundance. It is difficult to discriminate between formations based on individual elements. The McCaslin, Baraboo and Waterloo, as well as the Upper Lorrain at Willisville have an average Al_2O_3 content above 2% reflecting abundance of phylosillicate minerals (white micas). The McCaslin typically has a higher iron and sodium content than other geological sources. Potassium concentrations are lowest in the Hixton, Hinkley and Baraboo sandstones. The Bar River Formation material from the Sheguiandah site is difficult to distinguish from most other formations, except the Hixton which has a lower K_2O and minimal Al_2O_3 content.

While major element analysis is useful in determining bulk chemical characteristics, which can be used to determine the extent of chemical weathering affecting the system (CIA of Nesbitt and Young 1982, in Table 10.2), trace elements can be more useful as provenance indicators, as they are influenced by heavy mineral types, as well as by diagenetic and metamorphic processes. In this study we also used XRF analysis of powdered samples (about 5 g) to obtain data for 14 minor and trace elements, the data are presented in Table 10.3.

As with the major elements there is considerable overlap between samples. The Hinkley and McCaslin have the highest average zirconium concentrations (related to detrital zircon content). The Mesnard Formation and Naganee, and Mt. Mesnard, as well as correlative strata in the Sturgeon Formation have higher copper and niobium concentrations. The Sturgeon Formation might be distinguished from correlative strata using zinc concentrations. Samples of the Bar River Formation from the Shequiandah cannot clearly be distinguished from other formations with these data.

In this and earlier preliminary studies Julig *et al.* (1998b) used instrumental neutron activation analysis (INAA) on 154 geological and 22 archaeological samples, using the SLOWPOKE Research Reactor facility at the University of Toronto, for short-lived radio-isotopes. This method has the advantage of requiring only a small sample (200 to 600 mg), such that small artifacts (50 to 10,000 mg) can be analyzed directly for short half-life producing elements. INAA represents an appropriate non destructive method for analysis of whole artifacts which can then be returned to their curators undamaged. Elemental data were obtained using INAA for Al, Ba, Ca, Cl, Dy, K, Mg, Mn, Si, Na, Sr, Ti, U, V, Sm, and La, Br, Cu, I, and Ag were also determined, but could not be used with confidence due to inadequate counting statistics. The use of INNA analysis to source lithic artifacts is gradually being utilized in the Great Lakes Region and will improve as additional data on geological formations becomes available (Julig *et al.* 1998b).

While the raw tabular data (Table 10.4) might be used to discriminate some of the potential sandstone sources, canonical discriminant analysis of the INAA elemental data allowed differentiation of most of the primary geological sources (Figure 10.6). All geological samples of Hixton Silicified Sandstone, and samples from the Mesnard, Bar River, and Lorrain Formations were correctly classified into their groups. Of the 8 samples of Ajibik analyzed using INAA, 5 were correctly classified as Ajibik, and 3 were misclassified as Upper Lorrain. The multiple elemental data, with this limited suite of samples, show that geochemical differences may be used to separate the sources and potentially provenance quartzite artifacts.

Results of Chemical Analysis of Quartzite Artifacts

Artifacts from the Cummins site near Thunder Bay Canada (Figure 10.1) visually identified as possible Hixton Silicified Sandstone (HSS) had previously been tested using INAA (Julig *et al.* 1987) using short-lived isotopes. They were tentatively confirmed at that time as Hixton, based on a very limited selection and number of geological reference samples. The INAA geological reference data base was later supplemented (in Julig *et al.* 1998 b) with 22 geological samples of Hixton, 8 of Ajibik, 10 of Mesnard, 16 of Bar River, and 4 of Upper Lorrain (Willisville). Although the number of reference samples is yet modest, the preliminary INAA results are of interest as three of the four Cummins artifacts were confirmed as being Hixton Silicified Sandstone .

In addition to the Cummins artifacts specimens tested, three flake debitage collections provided by David Ruggles (8 sub-samples), previously visually identified as Hixton from Baby Lake site in Northern Michigan (Gorto et. al. 1993) were tested. Archaeological (Hixton?) flake debitage was also obtained (courtesy of Ruggles) from the Renier site collections, Brown County Wisconsin, a Late-Paleoindian cremation excavated by Mason and Irwin (1960). A total of 5 sub-samples were tested from Renier. In addition 5 sub-samples of an artifact visually identified as possible Sheguiandah quartzite (Bar River Formation) from the Sluyter site (provided by Paul Lennox) site were tested by INAA.

The 22 small (300-800 mg.) archaeological sub-samples were analyzed by SLOWPOKE INAA for 16 short-lived radio-isotope producing elements, and the results of selected elemental data are in Table 10.4. The results of the discriminate analysis for the archaeological samples are shown (Figure 10.6), along with the 5 primary geological sources. As discussed previously, the 5 geological sources distinguished reasonably well (except for the Ajibik Formation). Nine of the 22 artifact samples were statistically grouped with Hixton, including the 3 of the Cummins specimens previously identified by INAA (Julig *et al.* 1987), and all of the five Renier artifact sub-samples visually identified by Mason and Irwin (1960) were confirmed as Hixton sandstone. The five Sluyter site artifacts sub-samples, believed to be derived from the Sheguiandah Bar River Formation were grouped with the Bar River geochemical group. The Baby Lake site debitage sample results previously thought to be Hixton sandstone were not confirmed by the chemistry, with 7 of the 8 artifact samples grouped with the Upper Lorrain Fm. (Lateral equivalent of the Mesnard Fm.), and only one was classified as Hixton. It is evident that visual identification of certain quartzarenite artifacts does not always match with geochemistry.

Table 10.2. Major elements (oxides) of geological quartzite determined by XRF analysis.

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO	Na_2O	K_2O	P_2O_3	CIA*
Cambrian: Wonewoc Formation (Hixton Silicified Sandstone)											
n = 9	98.28	0.08	0.40	0.25	0.004	0.07	0.06	0.45	0.01	0.02	55.86
range, %	96.5-99.3	0.03-0.45	0.11-0.30	0.15-0.25	0.002-10	0.04-0.20	0.01-0.22	0.02-2.31	0.00-0.10	0.01-0.04	39-73
Mesoproterozoic: Hinkley Sandstone											
n = 4	96.54	0.13	1.51	0.22	0.003	0.05	0.08	1.00	0.04	0.02	56.75
range, %	98.0-93.9	0.06-0.28	0.67-2.73	0.11-0.37	0.001-5	0.04-0.05	0.00-0.17	0.47-1.75	0.02-0.06	0.00-0.02	38-75
Late Paleoproterozoic-Mesoproterozoic: Baraboo Formation											
n = 9	95.76	0.13	2.12	0.67	0.003	0.04	0.08	0.62	0.04	0.02	69.25
range, %	88.5-98.2	0.06-0.25	0.07-6.52	0.28-1.32	0.001-5	0.04-0.05	0.02-0.13	0.21-1.38	0.01-0.09	0.01-0.03	6-86
Late Paleoproterozoic-Mesoproterozoic: Waterloo Formation											
n = 1	91.88	0.12	4.21	0.71	0.005	0.07	0.16	0.80	1.27	0.02	66.30
Late Paleoproterozoic (2.1-1.9 Ga): McCaslin Formation											
n = 4	90.78	0.22	3.08	2.55	0.006	0.04	0.34	1.48	0.61	0.02	67.18
range, %	83.1-97.9	0.09-0.48	1.10-5.64	0.27-6.91	0.003-5	0.03-0.05	0.05-1.09	0.29-4.68	0.02-1.19	0.00-0.03	49-76
Late Paleoproterozoic: Agibik Quartzite											
n = 15	97.34	0.08	0.98	0.45	0.006	0.04	0.01	0.29	0.28	0.03	61.20
range, %	95.2-98.8	0.05-0.19	0.42-1.63	0.05-2.18	0.002-19	0.03-0.06	0.02-0.34	0.01-0.62	0.01-0.81	0.00-0.27	34-96
Early Paleoproterozoic (2.2-2.4 Ga): Bar River Formation, Sheguiandah archaeological site											
n = 6	96.5	0.09	1.62	0.18	0.003	0.04	0.04	1.17	0.33	0.01	48.2
range, %	93.7-98.2	0.05-0.14	0.77-4.26	0.13-0.25	0.002-0.008	0.03-0.05	0.01-0.07	0.69-2.50	0.07-1.00	0.00-0.30	37-75
Early Paleoproterozoic: Bar River Formation, other parts of Manitoulin Island											
n = 13	96.46	0.09	1.66	0.19	0.002	0.05	0.04	1.22	0.31	0.01	56.12
range, %	93.1-98.8	0.05-0.22	0.77-3.05	0.11-0.31	0.000-6	0.03-0.10	0.01-0.13	0.49-3.57	0.06-0.78	0.00-0.03	21-80

Table 10.2 (continued).

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	CaO	MgO	Na_2O	K_2O	P_2O_3	CIA*
Early Paleoproterozoic: Bar River Formation, Killarney Provincial Park, Lumsden Lake site											
n = 12	98.25	0.06	0.73	0.04	0.004	0.10	0.12	0.28	0.10	0.01	64.68
range, %	96.0-99.3	0.00-0.15	0.36-1.33	0.01-0.16	0.001-12	0.03-0.34	0.01-0.40	0.03-0.65	0.05-0.27	0.00-0.04	42-76
Early Paleoproterozoic: Mesnard Formation, Mount Mesnard											
n = 13	96.51	0.08	1.16	0.64	0.006	0.05	0.08	0.21	0.23	0.02	72.05
range, %	91.2-98.6	0.06-0.13	0.46-2.58	0.07-3.89	0.000-14	0.04-0.07	0.03-0.13	0.01-0.57	0.09-0.65	0.00-0.03	55-84
Early Paleoproterozoic: Mesnard Formation, Naganee											
n = 7	97.16	0.07	1.32	0.45	0.008	0.04	0.06	0.31	0.25	0.01	68.91
range, %	96.1-97.7	0.04-0.11	0.95-1.98	0.26-0.78	0.003-12	0.03-0.05	0.04-0.10	0.14-0.41	0.13-0.47	0.01-0.02	64-75
Early Paleoproterozoic: Mesnard Formation, Sturgeon Quartzite, Randville											
n = 3	95.04	0.07	1.58	1.43	0.010	0.10	0.24	0.59	0.56	0.02	54.97
range, %	94.1-95.9	0.07-0.08	1.10-2.24	0.97-1.92	0.007-12	0.06-0.16	0.17-0.29	0.03-1.07	0.23-1.14	0.01-0.02	47-65
Early Paleoproterozoic: Lorrain Formation, Upper Member, Barnetts Side Road, Sheguiandah Hill											
n = 3	97.06	0.06	1.52	0.13	0.003	0.03	0.02	0.87	0.20	0.01	71.32
range, %	95.3-98.7	0.04-0.08	0.76-2.07	0.12-0.14	0.001-7	0.03-0.03	0.00-0.04	0.17-2.02	0.07-0.42	0.00-0.01	46-85
Early Paleoproterozoic: Lorrain Formation, Upper Member, Willisville											
n = 10	96.64	0.08	2.16	0.13	0.005	0.04	0.03	0.39	0.23	0.02	74.61
range, %	94.3-98.5	0.04-0.24	1.00-3.75	0.03-0.25	0.002-14	0.03-0.06	0.01-0.06	0.07-0.66	0.06-0.60	0.00-0.03	51-86
Early Paleoproterozoic: Lorrain Formation, Upper Member, Rydal Bank											
n = 9	96.93	0.08	1.35	0.42	0.010	0.07	0.05	0.30	0.21	0.01	70.25
range, %	93.4-97.8	0.06-0.10	0.62-1.44	0.31-0.80	0.001-16	0.04-0.18	0.01-0.15	0.01-0.47	0.00-0.84	0.00-0.02	58-91

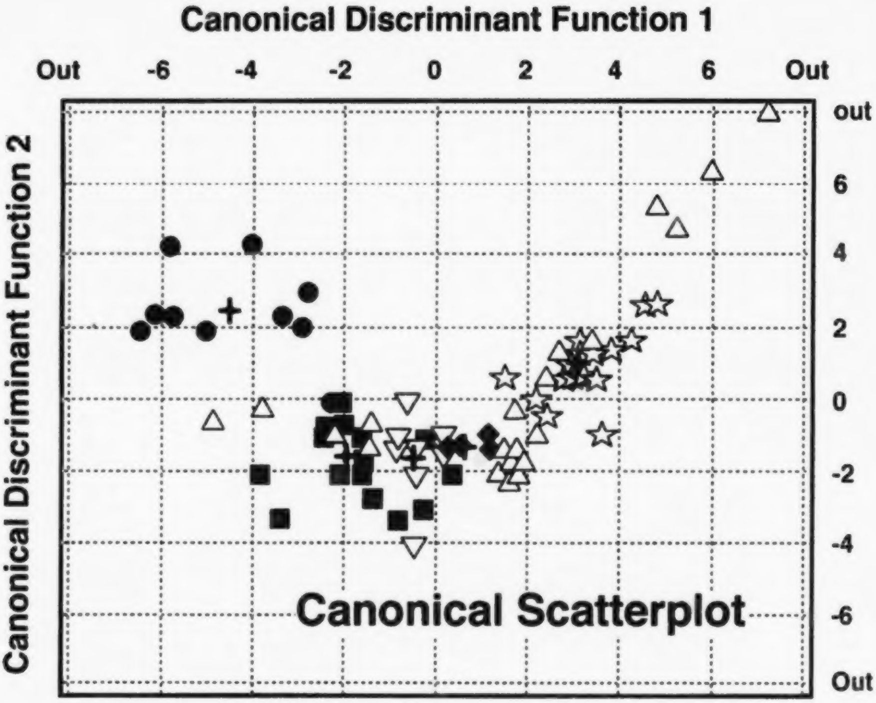
* CIA = (Al_2O_3 x 100)/(Al_2O_3 + CaO + Na_2O + K_2O), after Nesbitt and Young 1982

Table 10.3. Trace elements determined by CRF analysis of geological quartzite samples.

ppm	Sc	V	Cr	Co	Ni	Cu	Zn	Nb	Zr	Y	Sr	Rb	Ba	Pb
Cambrian: Wonewoc Formation (Hixton Silicified Sandstone)														
n = 5	0.5	3	266	335	3.7	7.6	1.6	96.1	29.1	4.2	11.9	0.5	52.7	3
range	0.5-1.2	0.9-8.3	234-340	289-375	0.3-9.9	0.6-17.4	0.3-4.9	78-115	28-32	1.0-7.0	9.7-13	0.0-0.8	35-68	0.8-5.3
Mesoproterozoic: Hinkley Sandstone														
n = 4	0.90	5.9	165.3	202.8	0.8	19.1	0.8	46.8	170.8	10.3	21.4	0.5	54.4	5.8
range	0.7-1.0	0.1-12.1	145-170	130-271	0.4-1.3	10.3-28.7	0.5-1.1	34-53	56-340	4.9-17.6	12.0-34	0.3-0.9	37-84	1.3-8.4
Late Paleoproterozoic-Mesoproterozoic: Baraboo Formation														
n = 9	0.9	4.7	233.6	394.2	7.0	12.2	1.0	79.2	141.3	9.0	64.1	1.3	44	7.4
range	0.2-1.5	0.3-11.2	87-412	96-1108	0.1-23.0	0.1-49.1	0.3-1.4	27-152	68-303	4.1-17.0	43.8-90	0.1-4.0	29-75	1.0-26.8
Late Paleoproterozoic-Mesoproterozoic: Waterloo Formation														
n = 1	1.0	14.6	165.3	208.1	0.9	1.8	5.9	55.2	82.4	10.4	15.7	29.8	330.8	16.1
Late Paleoproterozoic (2.1-1.9 Ga): McCaslin Formation														
n = 4	1.4	12.8	186.9	254.7	4.9	4.2	7.6	54.1	157.8	9.5	25.2	20.1	149.8	22.5
range	1.0-2.2	0.7-34.3	127-272	98-307	1.1-8.9	0.8-7.5	0.5-23.7	35-61	73-364	4.0-19.2	9.7-41	1.0-38.9	86-275	0.7-58.2
Late Paleoproterozoic: Agibik Quartzite														
n = 11	0.7	7.1	274.0	332.8	8.3	11.9	2.3	81.8	44.4	3.5	8.3	2.8	52.5	5.5
range	0.0-1.9	3.7-11.9	195-454	153-507	0.6-15.9	2.6-19.4	0.4-7.8	52-124	27-117	0.7-8.8	5.8-14	0.5-7.0	31-70	0.2-13.0
Early Paleoproterozoic (2.2-2.4 Ga): Bar River Formation, Sheguiandah archaeological site														
n = 5	0.9	3.4	172.6	199.1	0.4	4.3	0.5	59.6	79.5	7.5	8.1	6.8	97.6	7.1
range	0.4-1.5	1.2-6.8	123-233	123-249	0.0-0.9	0.5-11.0	0.1-1.1	42-81	43-168	4.7-12.2	5.1-11.7	0.2-17.4	64-161	1.1-13.6
Early Paleoproterozoic: Bar River Formation, other parts of Manitoulin Island														
n = 13	1.2	6.3	193.7	219.6	1.3	15.3	0.8	63.0	73.4	7.5	19.1	4.1	102.1	5.7
range	0.7-1.9	0.5-12.0	153-276	163-363	0.3-3.7	1.0-34.9	0.2-1.8	47-110	25-206	0.8-12.7	8.2-29.0	0.3-12.3	39-210	0.2-13.9

Table 10.3 (continued).

ppm	Sc	V	Cr	Co	Ni	Cu	Zn	Nb	Zr	Y	Sr	Rb	Ba	Pb
Early Paleoproterozoic: Bar River Formation, Killarney Provincial Park, Lumsden Lake site														
n = 8	0.9	2.3	8.8	178.9	0.1	12.7	0.7	3.1	36.7	7.7	11.6	1.4	164	4
range	0.0-1.3	0.2-4.4	0.1-17	112-230	0.0-0.2	0.7-28.7	0.1-1.5	0.9-5.4	20-74	3.2-16.2	8.0-19	0.2-4.8	71-337	0.7-10.7
Early Paleoproterozoic: Mesnard Formation, Mount Mesnard														
n = 9	0.8	9.4	239.5	427.5	10.0	22.2	2.6	85.6	60.5	4.9	9.4	4.2	103.4	8.4
range	0.1-1.5	0.0-31.8	177-270	245-1093	1.3-33.1	0.0-68.1	0.5-7.6	60-106	22-102	1.5-8.3	6.6-13.6	0.3-13.9	30-208	0.1-24.0
Early Paleoproterozoic: Mesnard Formation, Naganee														
n = 7	0.8	11.1	313.5	334.6	8.9	25.9	1.3	93.8	47.3	3.6	8.5	5.4	55.0	6.8
range	0.1-1.7	1.3-18.2	166-558	219-587	0.7-29.8	3.0-97.7	0.1-4.5	59-155	25-73	1.5-6.1	4.4-11.1	0.7-10.0	44-63	1.3-14.0
Early Paleoproterozoic: Mesnard Formation, Sturgeon Quartzite, Randville														
n = 3	0.9	4.7	274.6	412.4	15.8	24.0	35.9	90.4	72.2	7.2	9.5	5.0	43.7	12.4
range	0.4-1.4	2.8-7.5	196-392	200-696	3.1-25.1	0.8-53.7	3.1-75.2	63-120	57-90	5.8-8.1	6.7-13.0	0.8-12.5	18-62	1.1-27.8
Early Paleoproterozoic: Lorrain Formation, Upper Member, Barnetts Side Road, Sheguiandah Hill														
n = 3	1.2	4.3	173.5	195.2	1.4	10.7	0.3	53.1	49.0	7.3	27.9	2.2	72.3	0.4
range	0.3-2.2	1.1-7.5	168-179	185-208	0.1-2.1	1.0-20.1	0.1-0.6	49-56	32-78	3.3-13.8	14.7-46	0.3-5.2	54-87	0.2-0.9
Early Paleoproterozoic: Lorrain Formation, Upper Member, Willisville														
n = 10	1.4	5.5	159.6	179.6	1.5	16.9	0.4	46.6	69.6	5.6	35.5	2.4	83.1	3.7
range	0.5-2.8	0.5-15.0	13-299	123-277	0.0-4.8	7.1-40.6	0.0-0.6	4.4-75	50-133	2.3-8.8	9.0-53.5	0.1-7.1	34-201	0.8-9.7
Early Paleoproterozoic: Lorrain Formation, Upper Member, Rydal Bank														
n = 9	0.6	4.9	279.2	364.0	10.8	11.2	2.2	99.0	73.6	5.0	10.6	2.5	54.7	8.9
range	0.1-1.2	0.4-9.2	196-334	218-448	2.6-17.0	3.9-19.3	0.5-5.4	65-122	29-174	1.2-9.4	4.8-12.6	0.3-15.4	32-90	0.7-26.8



Group	Cases	Predicted Group Membership				
+ Group Centroid		▽	☆	●	■	◆
▽ Ajibik	8	5 63 %	0 0 %	0 0 %	0 0 %	3 38 %
☆ Hixton	22	0 0 %	22 100 %	0 0 %	0 0 %	0 0 %
● Mesnard	10	1 10 %	0 0 %	9 100 %	0 0 %	0 0 %
■ Sheguiandah (Bar River)	16	0 0 %	0 0 %	0 0 %	16 100 %	0 0 %
◆ Willisville (U.Lorrain)	4	0 0 %	0 0 %	0 0 %	0 0 %	4 100 %
△ Archeological (ungrouped)	22	0 0 %	9 41 %	0 0 %	5 23 %	8 34 %

Figure 10.6. Canonical scatter-plot based on discriminant analysis of INAA data (based on preliminary data in Julig *et al.* 1998b). See also INAA data on Table 10.4, of geological and archaeological samples tested.

Conclusions

As many of the potential geological sources of quartz-rich sandstones in the Great Lakes Region, and artifacts manufactured from them are visually very similar, destructive and non-destructive techniques may have to be applied to artifact collections to provide an adequate data base for provenance studies and cultural analysis. Multi-variant analysis of chemical data from x-ray fluorescence (XRF) and Instrumental Neutron Activation Analysis (INAA) analysis can provide differentiation of several of these potential sources, as can petrographic analysis. While these techniques are useful in identifying source material they normally involve partial destruction of samples, even in very small quantities. This may be unacceptable for museum curators. The use of cathodoluminescence (CL) microscopy offers an additional non-destructive mechanism which has no lasting effect of the sample. Samples of Hixton Silicified Sandstone can be clearly differentiated from older sandstones as the luminescence characteristic of the quartz grains, the early chalcedonic rim cements, and the late pore fill chert each have distinct luminescence characteristics (Fig 10.3f-h). Samples could also be distinguished from other petrographically similar Cambrian sandstones with luminescent rim cements by measuring the thickness of the rims. CL can also be used to identify older sandstones source rocks, although there is a greater degree of uniformity in the older samples.

The previous identification of artifacts as Hixton from Renier and Cummins sites is supported in this study, however the identification of Hixton material from the Baby Lake site was not correct, except for a single sample. It also appears that most of the quartzarenites, including the Bar River (including the Sheguiandah quarry) may be chemically differentiated, and artifact collections should be tested to determine ancient band ranges, trade and social interaction patterns.

It appears that Hixton Silicified Sandstone from Wisconsin, and possibly other quartz-arenites like Bar River, may have been special material to late Paleoindians and that it may have been transported as refined bifaces (points), biface pre-forms and as unifaces. These quartz sandstones seem to have been selected for rather than the cherts, which were also available and used by southern Ontario Paleoindians.

The visual identification of Hixton debitage and other artifacts based on macroscopic characteristics may be difficult, even for trained archaeologists, as the colour may be greatly affected by soil chemistry and other post-depositional factors. Cathodoluminescence appears to be a good choice for rapid non-destructive identification of Hixton, and geochemistry methods including INAA and XRF, as well as some traditional petrographic techniques may be used for positive identification of other archaeological quartzites. Quartzite artifacts from the Bar River Formation at Sheguiandah can be readily identified using standard petrographic techniques. CL is of little use, except to differentiate from Hixton material, as several of the older sandstones have similar uniform dull red CL. Sheguiandah material can be identified using INNA data, hence this technique is recommended for analysis of non-luminescent quartzarenite artifacts in the Great Lakes region.

Table 10.4. INNA analysis of sandstones and artifacts. Samples were analyzed at the SLOWPOKE Reactor

	Al-1	Br-	Ca-1	Cl-1	Cu-1	I	Mg-1	Mn-1	Si %
Sandstone analysis by INAA									
Cambrian: Wonewoc Formation (Hixton Silicified Sandstone)									
n = 21	641	0.24(5)	87	87	11(5)	0.13(5)	91	3.86	47.0
range	280-910	0.2-0.3	23-904	41-154	10-17	0.10-0.19	53-127	0.8-22	43-50
Mesoproterozoic: Hinkley Sandstone									
n = 4	788	0.73	53	43	23	0.31	1171	26.01	42.8
range	360-1480	0.2-1.7	23-110	39-51	13-31	0.1-0.6	260-2423	3.4-82	40-46
Late Paleoproterozoic-Mesoproterozoic: Baraboo Formation									
n = 9	1001	0.71	58	90	15	0.25	1459	11.39	44
range	400-2850	0.3-1.4	20-88	58-138	7-28	0.1-0.5	295-4785	4.3-20	40-45
Late Paleoproterozoic (2.1-1.9 Ga): McCaslin Formation, Quartz Mountain									
n = 4	1820	1.23	80	20	29	0.54	5503	32.61	44.25
range	570-3140	0.2-2.7	23-139	13-28	0.54	0.1-1.3	959-15160	2.3-107	40-48
Late Paleoproterozoic: Agibik Quartzite									
n = 19	1487	0.37(11)	42	49	14(11)	0.18(11)	958	4.07	46
range	460-2910	0.2-0.9	18-96	30-128	9-23	0.1-0.5	358-3624	0.6-41	44-49
Early Paleoproterozoic (2.2-2.4 Ga): Bar River Formation, Sheguiandah archaeological site									
n = 19	3348	0.99(15)	85	44	22(15)	0.41(15)	960	0.84	46
range	490-11800	0.3-2.1	19-236	19-59	8-55	0.1-0.6	387-3465	0.5-1.3	43-48
Early Paleoproterozoic: Bar River Formation, other parts of Manitoulin Island									
n = 13	812	0.48	45	48	12	0.18	1253	0.93	44
range	340-1580	0.2-0.9	29-62	29-75	7-18	0.1-0.3	356-2740	0.2-2.8	40-46
Early Paleoproterozoic: Bar River Formation, Killarney Provincial Park, Lumsden Lake site									
n = 8	493	0.93	837	36	16	0.28	1488	33.8	46
range	360-830	0.2-3.1	17-3266	21-54	7-36	0.1-0.9	287-3328	0.5-130	41-48
Early Paleoproterozoic: Mesnard Formation, Mount Mesnard									
n = 19	2165	1.11	83	75	19	0.39	957	1.4	46
range	420-5260	0.2-2.1	15-188	25-171	8-39	0.1-0.9	392-2709	0.9-3.2	42-48
Early Paleoproterozoic: Mesnard Formation, Naganee									
n = 7	736	0.31	34	38	10	0.12	1185	1.7	46
range	550-1030	0.2-0.4	20-59	24-45	8-13	0.1-0.2	730-1769	0.9-3.1	44-48
Early Paleoproterozoic: Mesnard Formation, Sturgeon Quartzite, Randville									
n = 3	787	1.30	781	22	28	0.58	2048	59.5	46
range	530-1300	1.2-1.4	291-1638	21-23	21-39	0.4-0.7	1701-3188	51-68	40-48
Early Paleoproterozoic: Lorrain Formation, Upper Member, Barnetts Side Road, Sheguiandah Hill									
n = 3	967	0.40	29	26	13	0.19	1157	0.61	47
range	420-1600	0.2-0.5	21-35	16-35	9-22	0.11-0.29	367-1912	0.2-0.9	45-49
Early Paleoproterozoic: Lorrain Formation, Upper Member, Willisville									
n = 14	1751	0.52(10)	44	55	15(10)	0.24(10)	1542	0.60	47
range	720-3160	0.2-0.9	24-78	30-86	8-25	0.12-0.44	467-4232	0.2-2.4	43-49
Early Paleoproterozoic: Lorrain Formation, Upper Member, Rydal Bank									
n = 10	764	0.78	63	209	14	0.20	997	1.24	46
range	290-2440	0.3-1.4	28-142	147-359	9-27	0.13-0.52	109-4185	0.6-1.9	45-48

* all data in ppm except silicon; elemental data varied by INAA facility.

Acknowledgements

Several individuals contributed samples of archaeological and geological materials including Caven Clark, David Ruggles, Jack Holland, Paul Lennox and William Ross. David Ruggles was particularly helpful in providing materials for Gorto and Renier site collections. Students at Laurentian University who assisted in laboratory analysis and sampling include Heidi Mathewson, Ian Gardner and Otis Crandel. Tristan Long acted as a field assistant during collec-

Facility, University of Toronto, and at SLOWPOKE II Facility at RMC in Kingston, Ontario.

Ti-1	U	V	Au-2	Ba-2	Dy-2	Eu-2	K	La-2	Na-2
Sandstone analysis by INAA									
Cambrian: Wonewoc Formation (Hixton Silicified Sandstone)									
49.2	1.14	0.5	0.06(5)	9.8	0.16	0.03(5)	120	2.12	23.2
34.4-70.4	0.1-2.7	0.2-1.4	0.05-0.06	4.7-19	0.10-0.25	0.01-0.03	50-348	1.4-4.3	14-35
Mesoproterozoic: Hinkley Sandstone									
427.3	0.67	4.1	0.14	27.5	1.5	0.21	154	6.55	34.3
128-1110	0.3-0.6	0.6-8.7	0.05-0.38	4.9-82	1.03-2.90	0.12-0.34	51-425	2.4-11.4	23-44
Late Paleoproterozoic-Mesoproterozoic: Baraboo Formation									
465	0.64	1.5	0.08	8.7	1.1	0.25	1342	10.57	84.8
152-1195	0.1-1.3	0.2-4.7	0.04-0.12	2.6-21	0.5-2.2	0.13-0.30	40-10230	7.8-17.2	21-257
Late Paleoproterozoic (2.1-1.9 Ga): McCaslin Formation, Quartz Mountain									
581.5	0.62	5.2	0.21	71.5	1.2	0.29	4554	18.98	287.0
295-1324	0.5-0.9	0.2-17	0.03-0.52	12.7-214	0.7-2.2	0.14-0.60	179-11670	8.2-38.7	64-654
Late Paleoproterozoic: Agibik Quartzite									
96	0.32	2.14	0.09(11)	6.0	0.2	0.12(11)	1334	3.48	40.7
37-330	0.1-0.7	0.7-5.4	0.03-0.23	3.8-12	0.1-1.1	0.07-0.22	247-3533	1.3-8.3	7-60
Early Paleoproterozoic (2.2-2.4 Ga): Bar River Formation, Sheguiandah archaeological site									
251	0.36	1.81	0.05(5)	44.5	0.67	0.22(5)	2107	12.8(9)	99.2
144-499	0.2-0.8	0.2-3.9	0.04-0.07	15-158	0.3-2.1	0.11-0.31	871-5436	1.0-19.5	37-283
Early Paleoproterozoic: Bar River Formation, other parts of Manitoulin Island									
310	0.37	2.48	0.06	49.3	1.10	0.33	2683	16.5	185.6
83-913	0.2-1.1	0.6-5.1	0.04-0.09	8-131	0.2-3.3	0.05-0.09	611-6436	2.6-40.3	57-652
Early Paleoproterozoic: Bar River Formation, Killarney Provincial Park, Lumsden Lake site									
94	0.35	1.31	0.17	123.7	0.63	0.14	1067	7.6	87.9
84-141	0.1-1.1	0.7-2.7	0.04-0.48	23-318	0.4-1.0	0.08-0.20	519-2238	1.0-19.5	26-349
Early Paleoproterozoic: Mesnard Formation, Mount Mesnard									
104	0.37	2.7	0.07(9)	51.8	0.58	0.01(9)	2235	4.2(9)	66.9
49-180	0.2-0.6	0.8-5.5	0.05-0.08	17-178	0.1-1.4	0.04-0.16	929-6081	1.4-8.5	33-135
Early Paleoproterozoic: Mesnard Formation, Naganee									
103	0.21	5.7	0.05	8.3	0.47	0.13	2605	6.9	44.6
59-156	0.1-0.3	1.6-9.9	0.03-0.06	5-13	0.3-0.7	0.04-0.28	1542-4167	1.6-24.5	35-67
Early Paleoproterozoic: Mesnard Formation, Sturgeon Quartzite, Randville									
77	0.48	3.9	0.33	23.4	0.31	0.06	4303	10.1	82.7
45-124	0.3-0.6	2.8-5.8	0.27-0.43	12-45	0.2-0.4	0.03-0.09	623-11590	8.4-13.1	25-193
Early Paleoproterozoic: Lorrain Formation, Upper Member, Barnetts Side Road, Sheguiandah Hill									
104	0.22	1.2	0.05	18.8	0.33	0.13	2143	7.1	199.3
39-143	0.1-0.3	0.5-1.7	0.03-0.07	11-33	0.2-0.4	0.03-0.21	643-4669	3.7-9.1	50-444
Early Paleoproterozoic: Lorrain Formation, Upper Member, Willisville									
248	0.42	1.5	0.05(10)	24.0	0.36	0.18(10)	1865	7.2	142.5
55-1719	0.1-1.4	0.2-6.3	0.04-0.08	4-129	0.1-1.1	0.07-0.25	569-4481	1.2-20.2	54-522
Early Paleoproterozoic: Lorrain Formation, Upper Member, Rydal Bank									
139	0.19	1.5	0.06	11.8	0.30	0.09	2142	4.2	141.3
21-325	0.1-0.2	0.2-2.6	0.05-0.10	5-24	0.1-0.9	0.05-0.19	67-9297	1.4-16.3	84-345

tion of geological material. This research was in part funded by the Social Sciences and Humanities Research Council of Canada and National Research Council of Canada.

References

Anstett, T.F. 1977. *Distribution of burrows in Upper Cambrian sandstones, Baraboo area, Wisconsin.* Master's thesis, University of Wisconsin.

Table 10.4 (continued).

	Al-1	Br-	Ca-1	Cl-1	Cu-1	I	Mg-1	Mn-1	Si %
Artifact analysis by INAA									
Renier site, Wisconsin									
RNR-1	840	-	53	189	-	-	99	2.47	47
RNR-2	920	-	68	279	-	-	100	4.99	47
RNR-3	940	-	66	264	-	-	205	3.08	48
RNR-4	990	-	94	435	-	-	127	5.86	47
RNR-5	890	-	44	305	-	-	113	2.17	48
Cummins site, northwestern Ontario									
CUM-1	800	-	90	34	-	-	0	7.63	51
CUM-2	1800	-	0	29	-	-	0	5.14	59
CUM-3	700	-	80	29	-	-	0	2.73	54
CUM-4	800	-	0	49	-	-	0	4.41	56
Baby Lake site, Michigan									
BL-1	1000	-	80	88	-	-	64	1.07	47
BL-2	800	-	60	69	-	-	52	2.90	47
BL-3	1000	-	106	97	-	-	67	1.03	46
BL-4	800	-	74	61	-	-	55	1.04	46
BL-5	800	-	86	71	-	-	57	1.02	46
BL-6	800	-	95	62	-	-	73	0.89	47
BL-7	1000	-	74	61	-	-	67	1.36	47
BL-8	1000	-	76	53	-	-	62	1.25	46
Sluyter site, southern Ontario									
SLY-1a	4450	2.4	188	60	43	1.03	869	1.27	46
SLY-1b	3310	1.0	71	43	19	0.45	617	0.86	47
SLY-1c	3540	2.0	165	59	37	0.90	568	1.05	46
SLY-1d	3410	1.6	121	60	28	0.79	587	1.25	47
SLY-1e	3650	1.1	99	45	19	0.50	712	0.96	47

Bakken, K. 1995. *Lithic raw material resources in Minnesota.* Text of paper presented at Annual Meeting of the Society for American Archeology, 3-7 May 1995, Minneapolis, Minnesota, 48 p.

Barker, C.E., and O.C. Kopp. 1991. Luminescence microscopy and spectroscopy: qualitative and quantitative applications. *SEPM (Society for Sedimentary Geology) Short Course 25,* 195 p.

Becker, H. 1931. A study of the heavy minerals of the pre-Cambrian and Paleozoic rocks of Baraboo Range, Wisconsin. *Journal of Sedimentary Petrology* 1: 91-95.

Behm, J.A., and A. Faulkner. 1974. Hixton Quartzite: experiments in heat treatment. *Wisconsin Archaeologist* 55: 271-276.

Boszhardt, R.F. 1994. Data recovery at Never Assume (47Tr174) and Kolbs Korner (47Tr176) sites on Arcadia Ridge in Trempealeau County, Wisconsin. *Reports of Investigations* 178, Mississippi Valley Archeology Centre.

Buckmaster, M.M. 1989. A Report on the Early Component at the Paquette Site, Marquette County, Michigan. *The Wisconsin Archaeologist* 70(4):430-462.

Buckmaster, M.M. and J.R. Paquette. 1988. The Gorto Site: Preliminary Report on a Late Paleo-Indian Site in Marquette County, Michigan. *The Wisconsin Archaeologist* 69(3):101-124.

Table 10.4 (continued).

Ti-1	U	V	Au-2	Ba-2	Dy-2	Eu-2	K	La-2	Na-2
Artifact analysis by INAA									
Renier site, Wisconsin									
53.2	0.13	-	-	4.96	0.12	-	138	-	32
57.5	0.17	-	-	12.30	0.14	-	173	-	36
69.0	0.37	-	-	4.68	0.11	-	146	-	26
48.8	0.20	-	-	6.25	0.14	-	236	-	31
52.9	0.45	-	-	6.44	0.09	-	180	-	29
Cummins site, northwestern Ontario									
64.1	0.30	-	-	0.00	0.19	-	0	-	30
52.6	0.26	-	-	12.40	0.00	-	0	-	50
45.5	0.37	-	-	0.00	0.15	-	0	-	0
63.5	0.29	-	-	9.29	0.18	-	0	-	20
Baby Lake site, Michigan									
41.0	0.23	-	-	9.60	0.11	-	240	-	33
38.0	0.18	-	-	7.20	0.12	-	192	-	17
65.0	0.28	-	-	10.40	0.19	-	240	-	21
39.0	0.24	-	-	7.80	0.12	-	194	-	25
48.0	0.22	-	-	16.40	0.14	-	200	-	23
56.0	0.26	-	-	11.40	0.13	-	240	-	29
54.0	0.40	-	-	10.00	0.13	-	240	-	30
46.0	0.24	-	-	9.20	0.11	-	220	-	27
Sluyter site, southern Ontario									
589.0	0.64	2.6	-	51.00	0.97	-	2150	-	63
212.0	0.37	1.8	-	25.10	0.41	-	1238	-	50
251.0	0.40	2.1	-	39.50	0.58	-	1910	-	61
186.0	0.29	2.2	-	31.10	0.51	-	1152	-	59
334.0	0.46	1.9	-	32.30	0.71	-	1332	-	52

Buell, I.M., 1892. Geology of the Waterloo Quartzite area. *Wisconsin Academy of Sciences, Arts and Letters, Transactions* 9: 225-274.

Calogero, B.L.A. 1992. Lithic Misidentification. *Man in the Northeast* 43: 87-90

Card, K.D. 1978. Geology of the Sudbury-Manitoulin area, Districts of Sudbury and Manitoulin. *Ontario Geological Survey, Report* 166, 238 p. Accompanied by Map 2360, scale 1 inch to 2 miles (1:126 720), and 4 charts.

Card, K.D., W.H. McIlwaine and H.D. Meyn. 1973. Geology of the Maple Mountain area, Operation Maple Mountain, Districts of Timiskaming, Nipising and Sudbury. *Ontario Division of Mines, Geological Report* 106, 160 p. Accompanied by Maps 2256; 2257; 2258; 2259, scale 1 inch to 1 mile, and Map 2260, scale 1 inch to 1/2 mile.

Church, T. 1996. *More than just collecting rocks: Contrasting views of lithic resource collections from the Rockies.* Paper presented at Society of American Archaeology Annual meetings, New Orleans, 9 pp.

Clark, C.P. 1989. Plano Tradition Lithics from the Upper Peninsula of Michigan. *The Michigan Archaeologist* 35: 88-112.

Dalziel, I.W.D., and R.H. Dott, Jr. 1970. Geology of the Baraboo district, Wisconsin. *University of Wisconsin-Extension, Information Circular* 14, 164 pp. + 6 plates.

Dott, R.H., Jr. 1973. Paleocurrent analysis of trough cross stratification. *Journal of Sedimentary Petrology* 43: 779-783.

Dott, R.H., Jr. 1974. Cambrian Tropical Storm Waves in Wisconsin. *Geology* 2: 243-246.

Dott, R.H., Jr. 1983. The Proterozoic red quartzite enigma in the north-central United States: resolved by plate collision. In *Early Proterozoic geology of the Great Lakes region*, edited by L.G.Medaris, pp. 129-141. Geological Society of America Memoir 160.

Dott, R.H. and I.W.D. Dalziel. 1972. Age and correlation of the Precambrian Baraboo Quartzite of Wisconsin. *Journal of Geology* 80 (5): 552-568.

Ebright, C.A. 1987. Quartzite petrography and its implications for prehistoric use and archaeological analysis. *Archaeology of Eastern North America* 15: 29-45.

Folk, R.L. 1980. *Petrology of sedimentary rocks*. Austin, Texas: Hemphill Publishing Company, 185 pp.

Frarey M.J. 1977. *Geology of the Huronian belt between Sault Ste Marie and Blind River, Ontario*. Geological Survey of Canada Memoir 383, 87 pp. + maps.

Geiger, C.A. 1982. Some aspects of the petrologic and tectonic history of Precambrian rocks of Waterloo, Wisconsin. *Geoscience Wisconsin* 6: 21-40.

Goodyear, A.C. 1989. A Hypothesis for the Use of Cryptocrystalline Raw Materials Among Paleo-Indian Groups of North America. In *Eastern Paleoindian Lithic Resource Use*, edited by C.J. Ellis and J.C. Lothrop, pp. 1-9. Boulder, Colorado: Westview Press.

Gorto, J., W. Lovis, D. Ruggles and R. Regis. 1993. Test excavations at the Baby Lake Site: a possible early site in Marquette country, Michigan. Unpublished manuscript on file at the Michigan State University Museum, East Lansing, Michigan, 8 p.

Hadley, D.G. 1968. *The sedimentology of the Huronian Lorrain formation, Ontario and Quebec, Canada*. M.Sc. Thesis, Johns Hopkins University, Baltimore, Md., 301 p.

Hewitt, D.F. 1963. *Silica in Ontario*. Ontario Department of Mines, Industrial Mineral Report 9, 36 p.

James, H.L., L.D. Clark, C.A. Lamey and F.J. Pettijohn. 1961. *Geology of central Dickinson County, Michigan*. U.S. Geological Survey Professional Paper 310, 176 p.

Julig, P.J. 1991. Late Pleistocene Archaeology in the Great Lakes Region of North America: Current Problems and Prospects. *Revista de Arqueologica Americana* 3: 7-30.

Julig, P.J. 1994. *The Cummins Site Complex and Palaeoindian occupations in the northwestern Lake Superior region*. Toronto: Ontario Heritage Foundation, Ontario Archaeological Reports 2, 236 pp.

Julig, P.J., D.G.F. Long and R.G.V. Hancock. 1998a. Cathodoluminescence and petrographic techniques for positive identification of quartz-rich artifacts from Late Paleo-Indian sites in the Great Lakes Region. *Wisconsin Archeologist* 19(1): 68-88.

Julig, P.J., D.G.F. Long, R.G.V. Hancock and L.A. Pavlish. 1998b. Provenance Studies of Late Paleoindian Quartzite Artifacts in the Great Lakes Region of North America Using Destructive and

Non-destructive Techniques. *Archaeometry 1998, proceedings of the 31st International Symposium on Archaeometry, Budapest Hungary.*

Julig, P.J. and J. McAndrews. 1993. Les cultures paléoindiennes dans la région des grands lacs en amérique du nord: contextes paléoclimatique, géomorphologiques et stratigraphiques in *L'Anthropologie* Tome 97(4): 623-650.

Julig, P.J., L.A. Pavlish and R.G.V. Hancock. 1987. Instrumental Neutron Activation Analysis of Archaeological Quartzite from the Cummins Site Thunder Bay: Determination of Geological Source. *Current Research in the Pleistocene* 4: 59-61.

Julig, P.J., L.A. Pavlish and R.G.V. Hancock. 1989. Late Palaeoindian lithic technological organization in the Northwestern Lake Superior region, Canada. In *Eastern Paleoindian Lithic Resource Use,* edited by C.J. Ellis and J.C. Lothrop, pp. 293-322. Boulder, Colorado: Westview Press.

Klemic, H., and Ohlson, J.M. 1983. Eau Clair Sandstone and Wonewoc Formation of Ostrom. In *Wisconsin Geological and Natural History Survey, Field Trip Guide Book* 9, edited by B.A.Brown, pp. 49-50.

Laberge, G.L., J.S. Klasner and P.E. Myers. 1992. New observations on the age and structure of Proterozoic quartzites in Wisconsin. In *Contributions to Precambrian Geology of Lake Superior region,* edited by P.K.Sims and L.M.H.Carter, pp. B1-B18. U.S. Geological Survey Bulletin 1904.

Larue, D.K. 1981a. The Choclay Group, Lake Superior region, U.S.A.: Sedimentologic evidence for deposition in basinal and platform settings on an early Proterozoic craton. *Geological Society of America Bulletin (Part 1)* 92: 417-435.

Larue, D.K. 1981b. The early Proterozoic pre-iron formation Menominee Group siliciclastic sediments of the southern Lake Superior region: evidence for sedimentation in platform and basinal settings. *Journal of Sedimentary Petrology* 51: 397-414.

Lennox, P. 1995. The Sluyter Site: A Prehistoric Neutral Hamlet, Waterloo County, Ontario. In *MTO Contributions to the Archaeology of the Late Woodland Period in Southwestern Ontario: Small Site Investigations*, edited by P.A. Lennox, pp. 8-76. London, Ontario: London Museum of Archeology Research Report 24.

Lindenberg, S.M. 1996. *Source characterization of western Lake Superior region lithics using neutron activation analysis: a geoarcheological study*. M.Sc. Thesis, University of Minnesota, 111 p.

Long, D.G.F. and A.C. Colvine. 1985. Geology and placer related gold potential of the Huronian Supergroup in part of the northwestern Cobalt Plain. In *Summary of Field Work and other activities 1985,* edited by J.Wood, O.L.White, R.B.Barlow and A.C.Colvine, pp. 242-246. Ontario Geological Survey, Miscellaneous Paper 126.

Long, D.G.F. and A.C. Colvine. 1986. Geology of the Huronian strata in part of the Northwestern Cobalt Plain. Including Sheard, Ogilvie, Amyot, Browning, Hodggets, Unwin, Lampman and Leask Townships and parts of North Williams, Dufferin, Stull, Valin and Marshay Townships. Districts of Timiskaming and Sudbury. *Ontario Geological Survey, Map P.3048*. Geological Series Preliminary Map, scale 1:50 000. Geology 1984 and 1985.

Lowey, G.M. and D.G.F. Long. 1985. Preliminary investigation of the sedimentology of auriferous strata in the early Aphebian (Huronian) Lorrain Formation, between Sault Ste. Marie and Sudbury, Ontario. *Geological Survey of Canada Paper* 85-1A: 97-101.

Marshall, D.J. 1988. *Cathodoluminescence of geological materials*. London, England: Unwin Hyman Ltd., 146 pp.

Mason, R.J. 1981. *Great Lakes Archaeology*. New York: Academic Press.

Mason, R.J. 1986. The Paleo-Indian Traditions. *Wisconsin Archaeologist* 67(3-4): 181-206.

Mason, R.J. and C. Irwin. 1960. An Eden-Scottsbluff burial in Northeastern Wisconsin. *American Antiquity* 26(1): 43-57.

McAuley, J. 1996. An evaluation of potential high-purity silica sources: preliminary site investigations. *Ontario Geological Survey Open File Report* 5948, 2 volumes.

Nesbitt, H.W. and G.M. Young. 1982. Early Proterozoic climates and plate motions inferred from major element chemistry of lutites. *Nature* 299: 715-717.

Ojakangas, R.W. 1983. Tidal deposits in the early Proterozoic basin of the Lake Superior region - the Palms and Pokegama Formations: evidence for subtidal-shelf deposition of Superior-type banded iron-formations. In *Early Proterozoic geology of the Great Lakes region*, edited by L.G.Medaris, pp. 49-66. Geological Society of America Memoir 160.

Olson, J.M. 1982. *Sedimentation and petrology of the Lower Proterozoic McCaslin Formation, northeastern Wisconsin.* M.Sc thesis, University of Minnesota.

Ostrom, M.E. 1987a. Cambrian stratigraphy at Whitehall, Wisconsin. In *North central section of the Geological Society of America,* edited by Donald L. Biggs, pp. 185-188. Boulder, Colorado: Geological Society of America, Decade in North American Geology, Volume 3.

Ostrom, M.E. 1987b. Late Cambrian Eau Claire Formation at Strum, Wisconsin. In *North central section of the Geological Society of America,* edited by Donald L. Biggs, pp. 183-184. Boulder, Colorado: Geological Society of America, Decade in North American Geology, Volume 3.

Porter, J. 1961. Hixton silicified sandstone: a unique lithic material used by prehistoric cultures. *Wisconsin Archaeologist* 42: 78-85.

Puffett, W. P. 1974. *Geology of the Nagaunee Quadrangle, Marquette County, Michigan.* U. S. Geological Survey Professional Paper 788.

Rust, B.R. and M.J. Shields. 1986. The sedimentology and stratigraphy of the Bar River Formation (Huronian Supergroup) at Bay Finn, Lake Huron. In *Geoscience Research Grant Program summary of research, 1985-1986*, edited by Milne, V. S., pp. 16-23. Ontario Geological Survey, Miscellaneous Paper 130.

Tankersley, K.B. 1988. The exploitation frontier of Hixton Quartzite. *Current Research in the Pleistocene* 5: 34-35.

Tankersley, K.B. 1989. A Close Look at the Big Picture: Early Paleoindian Lithic Research Procurement in the Midwestern United States. In *Eastern Paleoindian Lithic Resource Use*, edited by C.J. Ellis and J.C. Lothrop, pp. 259-292. Boulder, Colorado: Westview Press.

Tankersley, K.B., N.R. Shaffer and E.M. Ripley. 1988. Hixton Quartzite: petrographic and oxygen-isotope fingerprints as provenance tools. *Geological Society of America Abstracts with Programs* 20(7): 35.

Tryhorn, A.D. and R.W. Ojakangas. 1972. Sedimentation and petrology of the Upper Precambrian Hinkley Sandstone of east-central Minnesota. In *Geology of Minnesota: a centennial volume*, edited by P.K.Sims and G.B.Morley, pp. 431-435. Minnesota Geological Survey.

Turek, V and D. MacGregor. 1984. Badgeley Island quartzite deposit. In *The geology of industrial minerals in Canada*, edited by G.R.Guillet and W.Martin, pp. 134-136. Canadian Institute of Mining and Metallurgy, Special Volume 29.

Wanenmacher, J.M. 1932. *The Paleozoic strata of the Baraboo region, Wisconsin*. Ph.D. dissertation, University of Wisconsin, Madison, Wisconsin.

Wood, J. 1973. Stratigraphy and depositional environments of upper Huronian rocks of the Rawhide Lake-Flack Lake area, Ontario. *Geological Association of Canada Special Paper* 12: 73-95.

Wright, D.J. 1985. Preliminary report on the stratigraphy and sedimentology of the Huronian Bar River Formation, Ontario. *Geological Survey of Canada Paper* 85-1B: 111-116.

Young, G.M. 1983. Tectono-sedimentary history of early Proterozoic rocks of the northern Great Lakes. In *Early Proterozoic geology of the Great Lakes region*, edited by L.G.Medaris, pp. 15-32. *Geological Society of America Memoir* 160.

Young, G.M., D.G.F. Long, C.M. Fedo and H.W. Nesbitt. 2001. The Paleoproterozoic Huronian Basin: product of a Wilson cycle accompanied by glaciation and a meteorite impact. *Sedimentary Geology* 141-142: 233-254.

Chapter 11

Archaeological Conclusions from the Sheguiandah Site Research

Patrick J. Julig

Abstract

This chapter summarizes the various data sources from the previous chapters and extracts what we have learned about the Sheguiandah site, and its contribution to our understanding of Paleoindian and subsequent pre-ceramic occupations in the upper Great Lakes. The Sheguiandah site geochronology, site formation processes, and vegetation environmental context have been substantially resolved from this research, including most of the outstanding geological questions arising from the Lee investigations. Further more substantial excavations will be required to obtain representative archaeological assemblages of the site's occupants, to reveal lithic technological organization, and uncover evidence on subsistence practices. A late Paleoindian littoral adaptation is discussed, based on other regional Great Lakes shore line sites, archaeological and paleoecological data, and anthropological inferences from subarctic and arctic human adaptations in the circumpolar perspective.

Résumé

Ce chapitre a pour but de résumer les diverses sources de données fournies dans les chapitres précédents, d'extraire les enseignements sur le site de Sheguiandah et en quoi ils améliorent notre compréhension des occupations paléoindiennes et pré-céramiques subséquentes dans la région supérieure des Grands Lacs. Cette étude a apporté des éclaircissements substantiels sur la géochronologie du site de Sheguiandah, les processus de formation du site et le contexte environnemental de la végétation, y compris sur les questions géologiques restées en suspens après les études de Lee. En outre, des excavations d'envergure s'imposeront pour obtenir des assemblages archéologiques représentatifs des occupants des sites, mettre au jour l'organisation technologique lithique et découvrir des indices sur les pratiques de subsistance. Le chapitre contient une discussion sur l'adaptation du littoral à la fin de la période paléoindienne, discussion fondée sur d'autres sites riverains des Grands Lacs, des données archéologiques et paléoécologiques et des hypothèses anthropologiques faites à partir de l'adaptation de l'homme dans les régions subarctiques et arctiques dans la perspective circumpolaire.

Introduction

It has been half a century since the initial investigations by Lee, and over ten years since these re-investigations of Sheguiandah began, and it is now time to reflect on the overall outcome of the archaeological and geological re-investigations at the Sheguiandah site. What have we really learned, that was not evident in the Lee research and articles? This concluding

The Sheguiandah Site: Archaeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario, edited by P. Julig. Canadian Museum of Civilization, Archaeological Survey of Canada, Mercury Series Paper 161, 2002.

chapter briefly summarizes the contributions from previous chapters and highlights new information about the Sheguiandah site, focusing on its contribution to our overall understanding of Paleoindian behaviour, and the Plano and other pre-ceramic occupations in the upper Great Lakes. The second part of the this chapter reviews this early period of human occupation and paleoecology of the upper Great Lakes, during the Late Pleistocene to early Holocene transition (ca. 10,500 to 7500 years ago). In the final part of the chapter we consider the broader human adaptive patterns across the subarctic and boreal regions, as the glacial ice was retreating to the north and massive channels of meltwater drained through the landscape.

Our theoretical perspective is geoarchaeological, with the archaeology providing contextual information on human paleoecology. The archaeological, geological and paleoenvironmental findings are considered within the broader cultural patterns and long-term traditions that follow from the Paleoindian period in the Great Lakes and adjacent subarctic boreal regions.

As Willey and Phillips (1958: 2) noted some years ago, "American archaeology is Anthropology, or it is nothing". This perspective was later expanded by L.R. Binford (1972: 21) who said it is the job of archaeologists is to provide explanations of cultural process, how and why cultures change, not merely to excavate and provide data on material culture. While the documentation and explanation of culture change remains a key objective in archaeology, it is not always easy to accomplish when dealing with a single site, such as Shequiandah. The archaeologist needs to relate the site and the human patterns to the broader Great Lakes region through time and also to the changing natural environment. Since this was a time of considerable environmental change, one of the main goals in this concluding chapter is to consider the Sheguiandah site and Paleoindian populations in the context of this dynamic changing landscape. For example, if resources were to change rapidly, due to water level changes and other events, what types of adaptive strategies may be required? Would their survival strategies be similar to other northern boreal and subarctic populations, and how may this be expressed in the archaeological record?

One of the problems encountered in integrating the various chapters of this edited volume is that specialists from the various earth science disciplines (geology, palynology, pedology) do not normally organize their research methods and attempt to derive conclusions to reconstruct ancient human behaviour. The theoretical perspectives and methods in most chapters are strongly geological and/or paleoenvironmental. However the re-investigations were directed by archaeologists, and some of the key anthropological questions were reasonably well-integrated from the planning stages, by utilizing the human ecological or contextual approach (Butzer 1972; Julig 1994a, Julig *et al.* 1990, Julig *et al.* 1994; Stein and Farrand 1985; Waters 1992). This approach is now commonly referred to as a "geoarchaeological" perspective. The geoarchaeological perspective is the method by which specialists from the various areas (archaeologists, geologists, palynologists, soil scientists) each contribute an important part to the study and "reconstruction" of ancient human ecosystems, how they may have changed through time, and how this may have affected past human behaviour. The geoarchaeological perspective has three main objectives, as follows: 1) to date the sites and components by relative or absolute dating methods; 2) to understand the natural processes of site formation, and the deposition and preservation of material on a site; and 3) to reconstruct the natural landscape and ecological relationships at the time of site occupation (Waters 1992). We recognize that this perspective may be considered somewhat environmental (determinist) and that other types of (archaeological) information are required to gauge cultural change and it's causes (for example, see Long, Julig and Hancock, this volume).

We are still lacking some key parts of the puzzle, such as assemblages of animal or fish bones (zooarchaeological data) from the early components of Sheguiandah and many other early regional Paleoindian sites, to inform about pre-ceramic culture subsistence practices. We include in this chapter a brief summary of regional paleoecological data, specifically from other Paleoindian and paleontological (fossil) sites in the Great Lakes region (Figure 11.1), to provide the broad patterns of some species distribution and human use. Whereas a terrestrial big-game hunting strategy has been proposed for the Paleoindians generally, from archaeological, paleoecological, and ethnographic information, we propose a littoral or lake-shore adaptive strategy, not only for the Plano Paleoindians who initially colonized the Great Lakes inland seas, but also for their predecessors, the (Clovis) fluted point makers who first inhabited the southern Great Lakes and elsewhere (Roberts and Julig 1997) . This adaptive strategy also has long-term continuity for the region, along with parallels from other circumpolar subarctic adaptations.

Summary of and Reflections on Major Findings

Upon reflection, the reasons for re-investigation were two-fold. First, there was a general interest by academic archaeologists Julig (1985) and Storck (Julig and Storck, this volume), and geologists (Karrow 1987; P. von Bitter pers.comm. 2002), recognizing the need to resolve the long standing questions about the age and stratigraphic/sedimentary context of the site. While reanalysis and re-dating began in 1989, it was in the context of heritage planning and an archaeological master plan that new field re-investigations actually began. The local First Nations of Sheguiandah and Sucker Creek played important roles in bringing this about and in cooperating in both the archaeological surveys and the Elder interviews and compilation of the traditional use sites (Robertson *et al.*, this volume).

The fact that Thomas Lee reached out to the local Sheguiandah First Nations people in the 1950s (R. Lee, this volume) probably contributed in no small part to the open and cooperative relationship that made the re-investigations possible. However the perception of many local Sheguiandah village landowners about the designation of this site is negative. Many believe that they are disadvantaged by this designation, and for their property development and other activities, outside of the traditional land-use such as farming and pasturing. Also, the site designation was not registered on their land titles and some may have purchased the lands ignorant of the actual limitations to land use. While the need for protection of the site was clearly recognized by Thomas Lee, and he was ultimately successful in this regard, looting still continues to the present.

In terms of methods, Robert Lee documents how his father attempted to utilize some geoarchaeological methods, now commonly applied, possibly ahead of their time. He presents heretofore unpublished data on matrix fabric and other useful information lacking in previous reports, including on the Blasted Cave site. Unfortunately some of the organic samples like the fish bones and maple leaf (R. Lee, this volume) seem to have been lost from the collections. T. Lee's claim of Folsom type early Paleoindian fluted-points (letter from T.E. Lee to F. Knechtel, 1 Oct. 1954, as cited in R. Lee, this volume) has not been substantiated. However there is a very broad range of point forms, indicating long-term use of the Habitation Area by many prehistoric cultures.

T. Lee's cultural chronology has not been substantiated, as the points were found dispersed through-out several sedimentary strata (Storck, this volume), and limited support was found for technological change of the stone tool industry through time (Julig and Mahaney, this volume). Finally, Robert Lee's contribution (this volume), has provided valuable new spatial (e.g. Figure 2.15) and historical data, from the Lee archives, that may not have otherwise been published. I consider this a very important contribution to this book, and I hope it will help bring some closure to the Sheguiandah site controversy.

The remaining chapters in this interdisciplinary volume are considered with respect to three subjects: geochronology and time (dating the site), sedimentary/stratigraphic context, and paleoecology. When the Sheguiandah re-investigations began, the main question concerned the claim of ca. 30,000 years for the controversial Level III and IV deposits at the Habitation Area. People always asked, "How old is the site"? Resolution of this geochronology issue was approached by both archaeological and geological methods, and a variety of relative and chronometric dating techniques.

Geochronology and Dating

The analysis of the existing artifact collections, specifically the evidence from re-fitted (conjoined) artifacts indicated considerable mixing had occurred after the artifacts had been broken in manufacture and or use. This called into question the stratigraphic interpretations of Lee, and the relative age of the cultural "levels." When artifact refits were tabulated, typical artifact vertical separations often crossed one or more of Lee's stratigraphic levels (Table 4.3, Julig and Mahaney, this volume). The fact that the edges of the artifacts from Levels III and IV were not battered or crushed to any degree indicated that the post-depositional processes separating the artifacts were not glacial.

However, some quartzite artifacts from the Habitation Area sediments were water-worn, over their entire surfaces, as originally observed by T. Lee (Figure 4.8). These specimens, found from the humus to lower levels, indicated that the site had been flooded at some time subsequent to being first occupied. These relatively few water-worn artifacts provide a minimum "geological date" for when the site was first occupied. This inference is similar to findings for the initial component at the Cummins Site in Thunder Bay (Julig 1994a), which was also flooded.

Analysis of the points and technology also provide a "relative date," and these lines of archaeological evidence indicate late Paleoindian Plano and Archaic in the Habitation Area (Storck, this volume), with no early Paleoindian "fluted" points. The other artifact types and technology are also typical of this Great Lakes Plano culture elsewhere (Julig 1994a; Julig and Mahaney, this volume). While T. Lee claimed to have recovered of Folsom "fluted points" (see above), this claim has not been substantiated. A possible "Holcombe-like" point was illustrated by T. Lee, but it was not available for analysis (Storck, this volume). Although there was some evidence for more blade-like cores and bifaces with smaller width/thickness ratios in the lower levels (Julig and Mahaney, this volume), confirmation and the significance of such a trend will require re-excavations to produce representative sampling and a full analysis of the quartzite industry, including technological continuity and change.

Re-coring and sampling of Swamp 3 basal organic sediments, and AMS ^{14}C dates (Julig and Mahaney, this volume; Anderson, this volume) essentially confirmed the date that Lee (1957) had obtained for the base of Swamp 3 (9160 ± 250 BP). The mean of the three basal sediment (wood and peat) dates obtained by Julig and Mahaney is 9280 ± 80 BP, and the AMS date on conifer needles submitted by Anderson is 9470 ± 60 BP. The onset of organic sedimentation in the Swamp 3 is thus around 9500 radiocarbon years ago. Excavations did not reveal any artifacts in the clay (till) sediments below these basal organics (within a thin silt and sand below the peat).

The sediment studies also have a bearing on the site geochronology, as discussed below. The controversial Level III and IV sediments were shown to not be "tills." This indicates, contrary to the claims by Lee and Sanford, that the artifacts in Levels III and IV are post-glacial in age, nearly all post-Lake Algonquin in age, except a few specimens that exhibit water polished surfaces, as noted earlier.

The reconstructed lake-level history of the Huron Basin (Anderson and Lewis, this volume) indicates that the site was inundated by the short-lived Early Mattawa flood event ca. 9600-9500 BP. That event may account for the few water-polished artifacts, and aspects of the sedimentary matrix in the Habitation Area. This also indicates some human use of the Habitation Area about prior to the 9600 BP flood event, possibly 10,200 – 9700 BP.

Site Formation Processes and Sediment Analysis

While the dating and artifact studies provided several lines of evidence that the Sheguiandah Habitation Area artifacts are mostly post Lake Algonquin in age, it was necessary to address the question of origin of the mixed deposits. For this sediment analyses were required, including grain-size analysis, SEM studies, fabric studies, fossil content, boulder striations, mineralogy, soil profiles and field observations.

The studies of the existing sediment samples provided useful information, but the new excavations, and comparison to off-site tills, and other sedimentary contexts, including bay-mouth bar and lagoon environment sediments, were required to show that the controversial Level III and IV mixed deposits did not compare closely with other local till (Barnett, this volume). This was probably the most important demonstration of the type of near-shore or beach deposits that formed the Sheguiandah site Habitation Area. Also, the only on-site till was shown to be below any artifact bearing horizons. Boulder striation and fabric studies likewise did not provide support for glacial origin for Levels III and IV (Barnett, Julig and Mahaney, and R. Lee, this volume, agreed on most issues).

The SEM studies of quartz sand grains showed surface textures that are formed from lacustrine rather than glacial processes (Julig and Mahaney, this volume).

Finally, the conodont microfossils for the Mystic Ridge compared favorably with the Habitation Area sediments, indicating that the local Ordovician deposits were a sediment source (von Bitter, this volume). This was a very ingenious method and provided strong support for the modified beach deposit hypothesis for the mixed sediments.

Landscape and Paleoenvironmental Context

The geological context is the basis of the natural environment, influencing the vegetation, surface deposits, soils, drainage, and spatial distribution and qualities of lithic materials available for stone tools. The contributions of von Bitter and Long *et al.* (this volume) are important in this regard.

The Huron basin water level chronology is complex, and in this volume two models are presented. The traditiónal gradually declining water model from main Lake Algonquin, with the site emerging around 9500 years ago, during the Sheguiandah to Korah Phase time (Barnett, this volume; von Bitter, this volume, Table 9.1); and the model proposed by Anderson and Lewis (this volume), where flood events from Lake Agassiz inundated the site between ca. 9600 and 9500 years ago. In the Anderson and Lewis model, with several major water fluctuations, the flood event from Lake Agassiz at around 9600 years ago lead to climatic cooling and a change in local vegetation, with spruce replacing pine after 9500 BP.

The details of the water level changes in the Huron Basin presented by Anderson and Lewis provide the basis for a more detailed dynamic understanding of the Sheguiandah site in the regional context. The site distance from the water can now be determined through time, from inundation to being tens of kilometers away, and the most likely times of major site use may be related to proximity to the Georgian Bay shoreline and aquatic resources such as fish.

The possibility of Georgian Bay being a closed basin (lake) isolated from the rest of the Great Lakes likewise requires a change in our understanding of the early regional paleoecology, and of the connections of Manitoulin Island to Bruce Peninsula (southern Ontario) and to the north shore at various times.

The details of pollen change (Anderson; Anderson and Lewis, this volume) studies indicate the dynamic nature of the vegetation changes, and presumably animal communities. The rate and direction of migration of the species into the de-glaciated landscape was variable, and with the flood events and multiple basin level changes the coastal zone ecology of the native populations would have entailed numerous local and regional adaptive shifts and changes in various types of site locations.

The foregoing studies have shown that despite major environmental change, the Sheguiandah site and Sheguiandah Bay area has been a locus of regular human occupation and use for nearly 10,000 radiocarbon years, this being equivalent to nearly 11,000 calendar years. The primary period of occupation was after 9500 BP, based on the artifacts found in the basal sediments of Swamp 3, with AMS dates of ca. 9500 years BP (Julig and Mahaney; Anderson, this volume). However the recovery of some water-worn artifacts, and a few artifacts in mixed archaeological near-shore beach deposits provide a "geological date" of >9600 BP, when the site was affected by either the waters of the Korah phase of Lake Algonquin (Barnett, this volume), or the Early Mattawa flood event (Anderson and Lewis, this volume). The site continued to be used on an intermittent basis during the Archaic and Woodland periods.

So, the billboard on Highway 6 advertising Sheguiandah Village, stating "Sheguiandah, 9,500 Years Old," is fairly accurate, except it should say 9500 "radiocarbon" years old.

Late Paleoindian Human Ecology and Adaptive Patterns

The Sheguiandah site is one of a number of Paleoindian sites in the Great Lakes region associated with ancient beach margins, a prominent aspect of early settlement patterns (Figure 11.1). In fact, this association with former glacial lakes has been successfully used in southern Ontario for focusing archaeological survey work to discover Early Paleoindian sites along the pro-glacial Lake Algonquin/Ardrea strandlines (Deller 1976; Storck 1982, 1984a, 1984b). Radiometrically dated materials from these beaches were used to establish the maximum geological ages for the strandlines (and sites), and for the north shore on Lake Ontario there are bracketing geological dates (Roberts 1984). Major site locations are shown on Figure 11.1.

Archaeological survey and excavations support the concept of a Great Lakes Paleoindian littoral site association/adaptation (Deller 1976; Jackson 1982; Julig 1991; Julig and McAndrews 1993; Storck 1982, 1984a, 1984b; Roberts 1988; Roberts (*et al.* 1987a; Roosa 1977; Roosa and Deller 1982). This littoral association/adaptation has regional continuity from the fluted point traditions into the subsequent Late Paleoindian (Eastern Plano) traditions in the upper Great Lakes region (Julig 1991; Julig *et al.* 1994; Julig 1994a).

In the upper Great Lakes basins including northern Lake Huron, there is a similar pattern of Late Paleoindian (Plano and Holcombe sites dating 8000 to 10,000 BP) in association with beaches or water levels of pro-glacial Lake Minong (Lakehead Paleoindian Complex: Fox 1975; Julig 1990, 1994a), and also at high water stands (Lake Algonquin or post-Algonquin phases) in northern Lake Huron such as Shequiandah (Lee 1954, 1955, 1957; Julig *et al.* 1994) and George Lake (Greenman 1966). The Paleoindians of these northern coasts also favored shoreline locations for their sites in view of their relatively high biological productivity and subsistence resources, and particularly in places where there were suitable lithic materials for stone tool manufacture. Site visibility along these northern coasts is largely a result of geological conditions and exposure at quarry and tool manufacture locations. At sites like Cummins in the northwestern Lake Superior (Dawson 1983; Julig *et al.* 1990, 1994) and Shequiandah (Lee 1954, 1955, 1957; Julig *et al.* 1994), Paleoindians quarried lithic material from primary bedrock sources to make stone tools, and large long-term sites also have "habitation areas." Excavations at sites like Cummins and Sheguiandah have shown that many of these lithic procurement quarry sites were used intermittently for centuries or millennia. At both the Cummins and Sheguiandah sites, water-polished assemblages indicate human occupation prior to the ca. 9500 BP flood event from Lake Agassiz, as discussed earlier. The sites may also have been used when not adjacent the water.

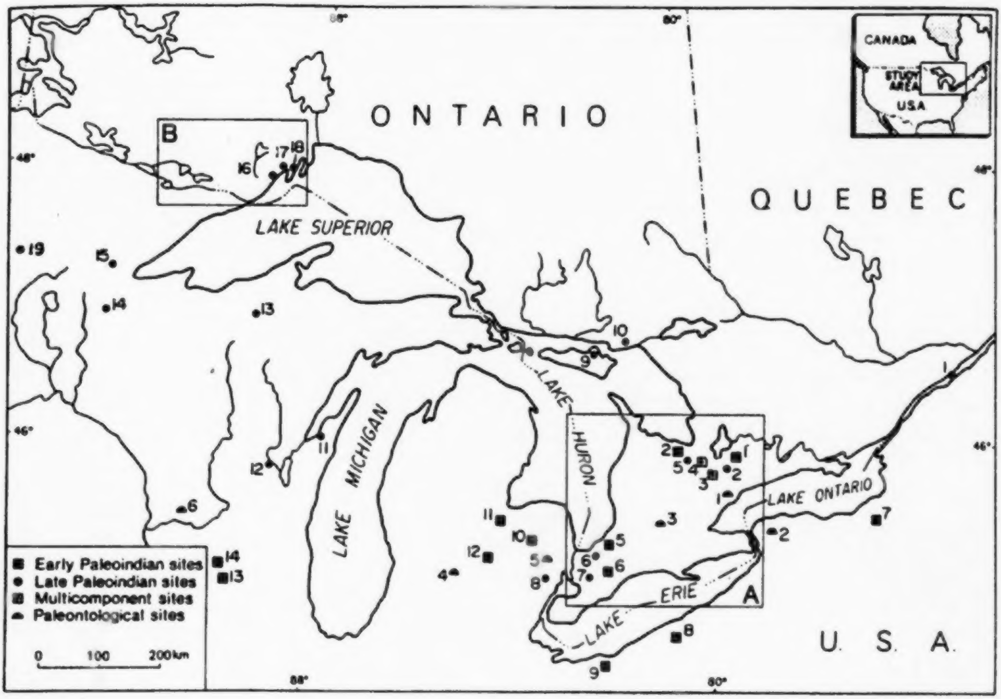

CANADA
STUDY AREA
USA
ONTARIO
QUEBEC
B
A
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ONTARIO
LAKE ERIE
U. S. A.
■ Early Paleoindian sites
● Late Paleoindian sites
▨ Multicomponent sites
▲ Paleontological sites
0 100 200km
88°
80°
48°
46°

Figure 11.1. Early and Late Paleoindian sites, paleontological sites, and modern shorelines in the Great Lakes Region. Multicomponent sites contain both Early and Late Paleoindian artifacts. Not all sites are shown: Box A contains many sites associated with ancient shorelines of Lake Algonquin and other water level (see Julig and McAndrews 1993), and Box B in the Lake Superior Basin contains many late-Palaeoindian sites of the Lakehead Complex (Julig 1994a). *Early Paleoindian sites*: 1 Udora, 2 Fisher, 3 Zander, 4 Hussey, 5 Parkhill, 6 Crowfield, 7 Potts, 8 Nobles Pond, 9 Silver Lake, 10 Gainey, 11 Barnes, 12 Leavitt, 13 Havey, 14 Kouba. *Late Paleoindian sites*: 1 Thomson Island, 2 Deavitt, 3 Zander, 4 Hussey, 5 Coates Creek, 6 Heaman, 7 Stewart and Welke Tonkonoh, 8 Holcombe, 9 Sheguiandah, 10 George Lake, 11 Reiner, 12 Pope, 13 Flambeau, 14 Suices, 15 Reservoir Lakes, 16 Cummins, 17 Biloski, 18 Brohm, 19 Itasca Lake. *Palaeontological sites*: 1 Toronto, 2 Hiscock, 3 Rostock, 4 Pleasant Lake, 5 Rappuhn, 6 Boaz

Since datable organics are not always preserved, archaeological interpretations of these late Pleistocene/Early Holocene Great Lakes shoreline sites are linked to and constrained by geological interpretations and lake-level chronologies. The geoarchaeological interpretations of late-Pleistocene/early Holocene shoreline sites may be greatly facilitated if the basin water level history is well dated and documented, and conversely interpretation and dating may be highly problematic, lacking clearly bracketing radiometric dates for the associated lacustrine geomorphic features. This may also arise, in the case of stratified sites, if the origin and/or date of certain strata are questionable, as was the case with the Sheguiandah site, as discussed previously. This indicates the great value of detailed works like those of Anderson and Lewis (this volume) and Barnett (this volume) to our archaeological interpretations.

Environmental Context

The Great Lakes northern coastal regions have been the focus of human habitation since shortly after de-glaciation, as soon as the natural terrestrial and aquatic ecosystems were productive for human subsistence resources. While the windswept northern coasts and boreal forest regions may be bleak and inhospitable in winter, rich migrations of waterfowl, fish, and herbivores occur seasonally, and they sustained the people through the centuries, despite changing environments. As the climate warmed and the glaciers retreated from the northern coasts (Figure 11.2), a herb tundra environment existed on the uplands within fifty to several hundred kilometers of the ice margin (Julig and McAndrews 1993). Based on the pollen studies this vegetational zone of tundra, at ca. 10,500 BP, had few tree species, except dwarf birch and willow, with grasses and cyperaceae being the major herbs. A diverse cold-adapted fauna favoured this tundra zone including mammoth (*Mammut americanum*), caribou (*Rangifer tarandus*), and other tundra-adapted species such as fox and hare were utilized at sites like Udora (Figure 11.1; Storck 1988).

However these late glacial tundra-like environments (Figure 11.2) were not similar to the northern high-latitude arctic environments. The amount of solar radiation and seasonal precipitation was very different, and the faunal communities were not comparable to modern associations, with the paleontological sites of this time having very diverse faunal assemblages including many now extinct species, as well as extant species.

Further to the south of the tundra zone (Figure 11.2) a spruce-lichen woodland habitat prevailed at this time, home to a more diverse animal fauna including mastodon (*Mammut americanum*), elk (*Cervus elaphus canadensis*) and other cervid species at sites such as Hiscock (Laub *et al.* 1988). The lower Great Lakes and southern Ontario south of about 46 degrees were occupied by Early Paleoindians (EPI; Julig and McAndrews 1993), and their most distinctive artifact was the fluted point. The Laurentide glacier had retreated to the north of Lake Huron by ca. 10,500 BP, and pro-glacial Lake Algonquin covered most of Manitoulin Island, and the northern shores, including the Sheguiandah site. As de-glaciation proceeded, northern drainage outlets were opened, and Lake Algonquin levels fell progressively to lower levels. After about 10,200 BP much of Manitoulin Island was exposed, including the Sheguiandah site, but on an intermittent basis due to fluctuating water levels. Paleoindians could have first occupied the site at this time (Anderson and Lewis, this volume).

By about 9500 BP, Lake Algonquin had subsided to the Korah level, so that the Sheguiandah site could have been continuously occupied (Barnett, this volume). Manitoulin was connected to the Bruce Peninsula in south central Ontario by this time (Figure 11.3), and the vegetation provinces had changed in response to climatic warming, with the pollen record indicating that pine was the dominant species ca. 10,200 to 9400 BP. However, it appears that a cooling period began, influenced by the cold waters of Lake Agassiz outflow into Lake Superior basin, with spruce returning to Manitoulin Island as the dominant species for about 500 years, before local climatic warming (Anderson, this volume).

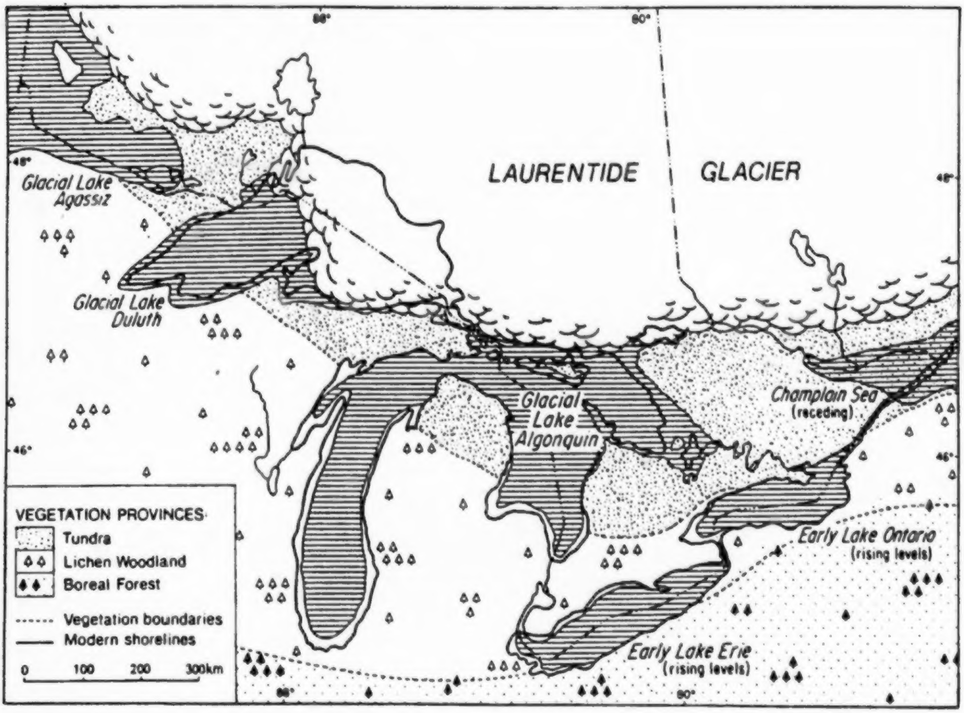

LAURENTIDE GLACIER
Glacial Lake Agassiz
Glacial Lake Duluth
Glacial Lake Algonquin
Champlain Sea (receding)
Early Lake Ontario (rising levels)
Early Lake Erie (rising levels)
88°
80°
48°
46°
VEGETATION PROVINCES
Tundra
Lichen Woodland
Boreal Forest
Vegetation boundaries
Modern shorelines
0 100 200 300km

Figure 11.2. Great Lakes water levels, glacial margins and vegetation provinces at ca. 11,000 to 10,500 BP (adapted from Julig and McAndrews 1993).

Late Paleoindian (Plano) populations occupied the northern regions of the Great Lakes (Figure 11.1), but sites of this period are not too common. Archaeological survey is, however, very difficult in the northern boreal regions, and few areas have been adequately surveyed. In those locations where farming and extractive activities have exposed surfaces (e.g. mining of gravel, or flooding for hydro-electric dams) surprising numbers of Late Paleoindian sites are recorded (e.g. Lakehead Complex around Thunder Bay; Reservoir Lake Complex near Duluth, Minnesota; Figure 11.1, Box B).

We do not have good indications of the subsistence practices of the Great Lakes Plano people, as bone preservation is generally poor in the acidic boreal forest soils, however caribou and other large mammal species, and fish were probably major subsistence resources. This resource base is common among many circumpolar subarctic and arctic populations from North America to northern Europe, for example, the prehistoric Saami populations (Julig 1994b) with larger interior sites commonly having a littoral focus implying the importance of aquatic resources, despite a reliance on larger ungulates such as caribou or reindeer.

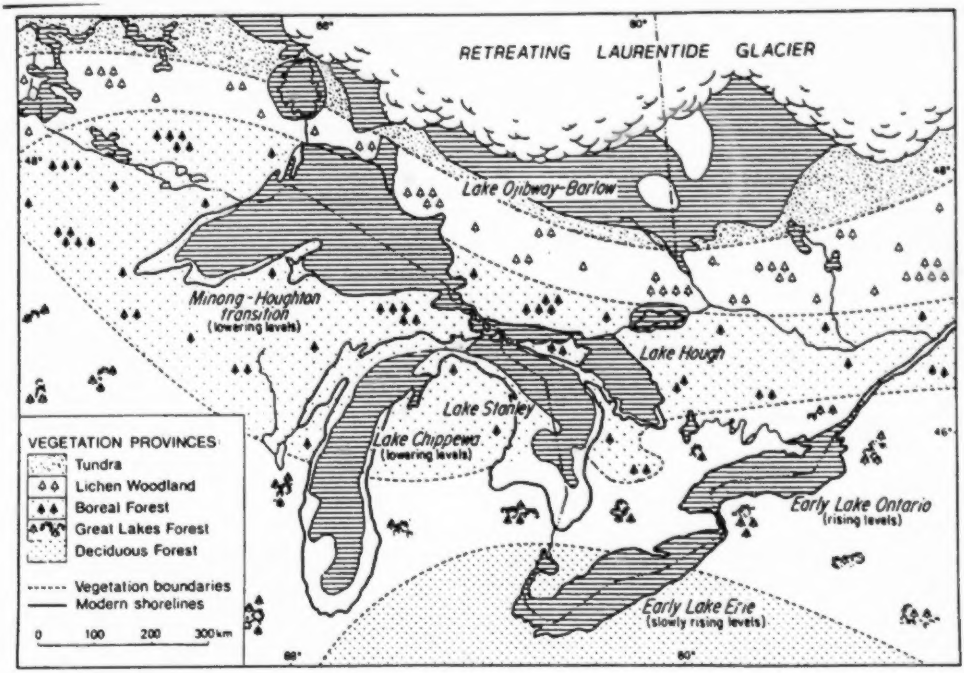

RETREATING LAURENTIDE GLACIER
88°
80°
48°
46°
Lake Ojibway-Barlow
Minong-Houghton transition (lowering levels)
Lake Hough
Lake Stanley
Lake Chippewa (lowering levels)
Early Lake Ontario (rising levels)
Early Lake Erie (slowly rising levels)
VEGETATION PROVINCES
Tundra
Lichen Woodland
Boreal Forest
Great Lakes Forest
Deciduous Forest
Vegetation boundaries
Modern shorelines
0 100 200 300km

Figure 11.3. Great Lakes water levels, glacial margins, and vegetation provinces ca. 9500 to 9000 BP (adapted from Julig and McAndrews 1993).

Across the Great lakes region a variety of animals, including deer, beaver, bison, moose and other species, are reported at paleontological and some Plano era sites (Julig and McAndrews 1993, Figure 11.1), but few sites have good faunal records, and subsistence data for this period is inadequate. Yet the coastal orientation implies the importance of aquatic resources, ranging from beaver to fish and waterfowl, as discussed below.

Discussion of Paleoindian Littoral Adaptation

The previous sections have considered the evidence from Sheguiandah and regional sites, both early and later Paleoindian sites being associated with ancient coastal shoreline contexts. This may appear to be somewhat at odds with the view that the Late Paleoindian Plano peoples moved directly into the Great Lakes region from the western plains, based on similar artifact (point) forms (see Storck, this volume). However, the Great Plains also had wetlands and Pleistocene lakes, and many of the most ancient sites are associated with such shorelines. This section considers the hypothesis (Roberts and Julig 1997) of a Paleoindian "littoral adaptation" in selected areas in North America (and a more detailed "littoral tradition" in the Great Lakes region).

Ethnographic information on northern circumpolar hunter-gatherer populations indicates that littoral adaptations are very common. While not excluding the hunting of larger terrestrial mammals in upland (non-littoral) regions or implying the use of watercraft for hunting or transportation aids, littoral adaptations suggest a generalized foraging economy and extended linear (coastal) band ranges.

By littoral adaptations we mean that within several regions from the northern Plains (Roberts and Julig 1997) to the Great Lakes, and through extended periods of several millennia, numerous Paleoindian habitation and other sites and locations are on or adjacent to (overlooking) beaches and strandlines of major water bodies and, based on sedimentological, geological, artifactual, radiometric, palynological and/or other data, are approximately contemporaneous with the active beaches, or the coastal wetlands and marshes. This association may include clear archaeological context (e.g. sites with waterworn artifacts or archaeological horizons within or below lacustrine deposits); however, in some cases, it has not been possible to demonstrate absolute contemporaneity. In such cases close proximity and relative age criteria, including artifact tool traditions and typology, may be considered.

Our use of the term "adaptation" is in a broad anthropological context. We considered the factors and constraints commonly encountered by hunter-gatherer bands living in seasonally cold environments, specifically northern boreal, subarctic (including parkland conditions) and arctic. Similar conditions and constraints could also commonly be expected in the late Pleistocene within proximity to the Laurentide or Cordilleran ice and/or cold proglacial Great Lakes or drainage channels, or the "ice free corridor" and Beringian regions. Conditions in the Great Lakes region were about 10 degrees cooler at 11,000 years BP than modern conditions (Julig and McAndrews 1993). If the Paleoindians were recent arrivals from such northern regions as Beringia and the "ice free corridor," they probably exhibited subsistence and settlement adaptive strategies appropriate to their region of origin. Alternatively, if they moved into the proglacial Great Lakes and other regions from the Great Plains or southern regions, specific cultural traits, subsistence pursuits and other adaptive strategies from this region of origin may be expected, along with cultural changes to the new conditions (Dillehay and Meltzer 1991).

Boreal and northern circumpolar hunter-gatherers' subsistence and settlement adaptations commonly faced similar constraints, including the need for reliable resources at critical periods and the necessity to travel and meet for social interaction and other cultural logistical reasons ranging from risk reduction to reproduction. For example, in circumpolar regions some food storage and caching (ranging from food to flint) is normally required for cold seasons, they being "collectors" rather than "foragers" in the Binford (1980) definition.

It is recognized that prehistoric hunter-gatherer cultures often favoured shorelines for settlement sites due to their biological productivity and subsistence resources, as well as a ready supply of fresh water. In subarctic boreal forest regions a littoral or riverine adaptation is typical for Algonquian groups, both for subsistence resources (fish, moose, beaver) and as travel corridors by canoe in the summer, and snowshoes and toboggans after freeze-up. Macro-bands tended to focus their large summer sites on the major lakes and rivers, these were often meeting and trading places.

In arctic regions, coastal adaptations by Inuit groups often involved a marine mammal focus (seal, walrus, whales), either on the coast in the summer months or near the ice edge or at polynias. Indeed, beach ridge archaeology has in the past been a major research strategy and relative dating procedure for the prehistoric cultural sequences and adaptations from the coastal Bering Straits region (Giddings 1967) to the Paleoeskimos of the high arctic islands and Greenland (McGhee 1996).

The barren ground region Chipewayans, who inhabit the parklands south of the tree line region and the Caribou Eskimo (Inuit) who occupy the barren grounds west of Hudson Bay as well as the Nascapi Cree east of Hudson Bay are often considered to be ethnographic analogues of the northeastern Paleoindians, with a caribou focal subsistence economy (MacDonald 1968). However for the Caribou Eskimo, "Fish formed a major food source, particularly when shifts in caribou migratory pattern or population fluctuations left the Caribou Eskimos short" (Arima 1984: 448).

There are interior oriented Inuit groups from the mountains of Alaska to the barren grounds of Northwest Territories focusing on caribou procurement. These bands had by necessity major seasonal sites beside larger rivers and lakes for fishing and other subsistence resources (Damas 1984). Because of the unreliability of caribou and muskox herds over the long term, Inuit groups could not rely on them exclusively, and some marine and/or lacustrine resources were typically required. These were commonly acquired at large sites with fish weirs, and by fishing through the ice as well.

Throughout boreal, subarctic parkland, and arctic regions essentially all ethnographically and archaeologically known cultures had major sites in littoral, riverine and/or marine coastal regions. Aquatic subsistence needs (mainly fish) are probably the major reason, but traveling ease, insect avoidance and other factors (caribou crossings) are also important.

Since Paleoindians populated territories within 300-500 kilometres of the Laurentide ice, at 11000 - 10000 years ago occupied by parkland and/or boreal forest environments (Julig and McAndrews 1993), we argue that broadly similar adaptive constraints would apply as with more recent hunter-gatherers. The same constraints would apply for the "ice free corridor" region from Alaska to Alberta and, very likely, within Alaska and Beringia. However, the variety and quantity of large game may have been much greater in the terminal Pleistocene, and the biological productivity of the lower latitude tundra and woodland environments may be much different from the northern analogues.

Although this volume does not deal specifically with Paleoindian colonization models, or the controversy over timing and ancestry, our data have certain implications in that regard. There has been considerable debate regarding the initial peopling of the New World. The principal controversy concerns the role of fluted point manufacturing Paleoindians and whether they developed out of an existing Paleoindian culture or were the initial inhabitants of the Americas moving from Beringia into the Americas over several millennia.

Although suggestions of a pre-fluted point Paleoindian occupation are many and varied, most discoveries can be criticized with respect to the dating techniques or the nature of the artifactual evidence or the context of the finds (Hoffecker *et al.* 1993; Lynch 1990). It is however quite clear that if there was a pre-fluted point Paleoindian presence in the Americas, the population was sparse and left almost no archaeological record. Conversely the fluted point finds indicate a small but well adapted and extensive Paleoindian occupation over a large area of North America (Fagan 1987) including Canada (Roberts *et al.* 1987a). Throughout Canada the adaptations and dates are remarkably consistent for the fluted point occupation, and adaptive continuities of the littoral adaptation appear into the subsequent Plano Paleoindian period (Roberts *et al.* 1987b).

Finally, the potential that many of these regional Paleoindian adaptations were littoral and oriented towards the hunting of large terrestrial mammals is consistent with a Beringian origin on the steppe-tundra adjacent to the flooding land bridge between Siberia and Alaska and the Bering Sea (Matthews 1982; Morlan 1977). These early highly mobile hunting groups may have pioneered the American continents by refining their arctic adaptation strategies and adapting them from the steppe-tundra and marine environments of the north to the plains and boreal forests adjacent to large pro-glacial and pluvial lakes further south.

Final Thoughts and Future Directions

The Sheguiandah site fits the pattern of early beach ridge littoral sites in the Great Lakes region, more commonly preserved along the northern shores due to glacial isostatic uplift. While it has complex natural stratigraphy, our studies found no evidence of a pre-Clovis component. It is similar to other upper Great Lakes Palaeoindian sites, like the Cummins site near Thunder Bay, both being large quarry/workshop sites, occupied during the terminal Pleistocene/early Holocene transition when the water levels were very dynamic from the glacial melting, and flood events affected the archaeological remains. A multi-disciplinary and geoarchaeological approach is essential to fully interpret such sites. This project was very fortunate in having experts in several fields willing to conduct detailed studies to answer a range of geological, archaeological and environmental questions.

Not all of the questions and issues were fully resolved, and some will await future work on this site and other sites across the region. For example, changes in quartzite stone tool technology (manufacturing) should be studied for the occupations on the different beach levels at the Sheguiandah site, from the Middle Woodland at the Algoma beach, the Middle Archaic below the Nipissing beach, and the Plano Paleoindian (and Early Archaic) at the Habitation Area and above. This represents about 8000 years of technological change in the same region on the same quartzite material. Possibly such a study can be accomplished by developing an Archaeological Park and Interpretive Center at Sheguiandah, as has been suggested. Designation of Sheguiandah as a World Heritage site through UNESCO is another possibility (Julig 1999).

While new site survey and excavation is required to learn about regional sites, of all types, CRM archaeology is helping greatly in this regard. However, detailed analyses are also needed, and studies of existing museum collections are very important in this regard. The methods now exist to learn much more about the extent of band ranges, social interaction networks and exchange patterns, by provenance studies of stone tools and other artifacts. These may be done non-destructively and the artifacts returned to the museums.

As Cultural Heritage studies are being directed more by First Nations involvement, it is anticipated that they will assume a larger role in this regard, in studying and interpreting their own heritage. We are certainly seeing this in Northern Ontario and it is a good sign for the future.

Acknowledgements

This volume has been dedicated to Thomas E. Lee, as noted in the Preface, and to all those who worked on this site in the past. The First Nations of Sheguiandah, Sucker Creek and the township of Howland were all involved in bringing about the re-investigations, which were directed by Archaeological Services Inc. Many individuals were involved, and most have been acknowledged in other chapters. However I wish to thank, in particular, Peter Storck for helping to bring together the team that helped to make these studies successful. Finally I would like to remember the late Clyde Kennedy, who was an amateur archaeologist extraordinaire, and who, by making a special trip to Sheguiandah to show me around the site in 1984, stimulated my interest in this project and ultimately this volume.

Research funding for this book was provided by several sources, including the Laurentian University Institute for Northern Ontario Research and Development and Laurentian University Research Fund grants, and also grants by the Social Sciences and Humanities Research Council and the Ontario Heritage Foundation to study the collections. Laurentian University has been most helpful over the years in providing the space and resources, and this support is most gratefully acknowledged.

References

Arima, E.Y. 1984. Caribou Eskimo. In *Handbook of North American Indians, Vol.5, Arctic*, edited by D. Damas, pp. 447-462. Washington, D.C.: Smithsonian Institution Press.

Binford, L.R 1972. *An Archaeological Perspective*. New York: Seminar Press.

Binford, L.R. 1980. Willow smoke and dogs' tails: hunter gatherer settlement systems and archaeological site formation. *American Antiquity* 45(1): 4-20.

Butzer, K. 1972. *Archaeology as Human Ecology: Method and Theory for a Contextual Approach*. Cambridge University Press.

Damas, D., editor. 1984. *Handbook of North American Indians, Vol.5, Arctic*. Washington, D.C.: Smithsonian Institution.

Dawson, K. 1983. Cummins site: a late Paleo-Indian (Plano) site at Thunder Bay, Ontario. *Ontario Archaeology* 39: 3-31.

Deller, D.B. 1976. Paleoindian locations on late Pleistocene Shorelines, Middlesex County, Ontario. *Ontario Archaeology*, 26: 3-19.

Dillehay, T. and D.J. Meltzer, editors. 1991. *The First Americans: Search and Research*. Boca Raton, Florida: CRC Press.

Fagan, B.M. 1987. *The Great Journey*. London: Thames and Hudson

Fox, W.A. 1975. The Paleo-Indian Lakehead Complex: new insights. In *Collected Archaeological Papers*, edited by D. Skeene Melville. Ontario Ministry of Culture and Recreation, Archaeological Research Reports 13: 127-154.

Giddings, J.L. 1967. *Ancient Men of the Arctic*. Toronto: Random House.

Greenman, E.F. 1966. Chronology of sites at Killarney, Canada. *American Antiquity* 31(4): 540-551.

Hoffecker, J.F., W.R. Powers and T. Goebel. 1993. The colonization of Beringia and the peopling of the New World. *Science* 259: 46-53.

Jackson, L.J. 1982. Geochronology and settlement disposition in the early Paleo-Indian occupation of southern Ontario, Canada. *Quaternary Research* 19: 288-299.

Julig, P.J. 1985. The Sheguiandah Site Stratigraphy: A perspective from the Lake Superior Basin. *Ottawa Archaeologist* 12(8): 3-13.

Julig, P.J. 1990. The Effect of Lake Agassiz Flood Events on Northern Great Lakes Paleo-Indian Sites: Examples from the Superior and Huron Basins. Paper presented at joint meetings of Canadian Quaternary Association and American Quaternary Association, University of Waterloo, June 1991.

Julig, P.J. 1991. Late Pleistocene Archaeology in the Great Lakes Region of North America: Current Problems and Prospects. *Revista de Arqueologia Americana* 3: 7-30.

Julig, P.J. 1994a.The Cummins Site Complex and Paleoindian Occupations in the Northwestern Lake Superior Region. Ontario Heritage Foundation, *Ontario Archaeological Reports 2*, 236 pp. University of Toronto Press.

Julig P. J. 1994b. Report on Reconnaissance Archaeological Survey conducted in the Norra Storfjällen Nature Reserve, Vasterbottens Läns, Sweden, 1993. In, *Tärna-Okstinden Glacial History Project 1990-93*. Center for Arctic Research, Umeå University, Sweden No. 28: 9-17.

Julig, P.J. 1999. Archaeological Theme Parks, Public Archaeology and Living Museums: Prospects for the Upper Great Lakes Region. In *La nature et la loi/Nature and Law*, edited by F.-X. Ribordy, pp. 113-130. Sudbury: Laurentian University Press.

Julig, P.J., J.H. McAndrews and W.C. Mahaney. 1990. Geoarchaeology of the Cummins Site on the beach of proglacial Lake Minong, Lake Superior basin, Canada. In *Archaeological Geology of North America*, edited by N.P. Lasca and J. Donahue. Boulder, Colorado: Geological Society of America, Centennial Special Paper 4: 21-50.

Julig, P.J. and J. McAndrews. 1993. Les cultures paléoindiennes dans la région des grands lacs en amérique du nord: contextes paléoclimatique, géomorphologiques et stratigraphiques. *L'Anthropologie* 97(4): 623-650.

Julig, P.J., P.L. Storck and W.C. Mahaney. 1994. Re-investigations at Sheguiandah: the Application of a Geoarchaeological Approach. In *Great Lakes Archaeology and Paleoecology: Exploring Interdisciplinary Initiatives for the Nineties*, edited by R.I. MacDonald, pp. 237-262. University of Waterloo, Quaternary Sciences Institute.

Karrow, P.F. 1987. Comments on: "Geology of the Sheguiandah Early Man Site: Key Concepts and Issues" by R.E. Lee. *Géographie Physique et Quaternaire* 41: 403-405.

Laub, R.S., M.F. Deremer, C.A. Dufort, and W.L. Parsons. 1988. The Hiscock site: a rich Late Quaternary locality in Western New York State, *Buffalo Society of Natural Sciences Bulletin* 33: 67-81.

Lee, T.E. 1954. The First Sheguiandah Expedition, Manitoulin Island, Ontario. *American Antiquity* 20(2): 101-111.

Lee, T.E. 1955. The Second Sheguiandah Expedition, Manitoulin Island, Ontario. *American Antiquity* 21(1): 63-71.

Lee, T.E. 1957. The Antiquity of the Sheguiandah Site. *Canadian Field Naturalist* 71(3):117-137.

Lynch, T.F. 1990. Glacial-Age Man in South America? A Critical Review, *American Antiquity* 55(1):12-36.

MacDonald, G.F. 1968. *Debert: a Paleo-Indian site in central Nova Scotia*. Ottawa: National Museums of Canada, Anthropology Paper 16.

Matthews, J.V., Jr. 1982. East Beringia during late Wisconsin time: a review of the biotic evidence. In *Paleoecology of Beringia*, edited by D.M. Hopkins, J.V. Matthews, Jr., C.E. Schweger, and S.B. Young, pp. 127-150. New York: Academic Press.

McGhee, R. 1996. *Ancient People of the Arctic*. Vancouver: UBC Press.

Morlan, R.E. 1977. Fluted point makers and the extinction of the Arctic-Steppe biome in eastern Beringia. *Canadian Journal of Archaeology* 1: 95-108.

Roberts, A.1984. Paleoindian on the north shore of Lake Ontario. *Archaeology of Eastern North America* 12: 248-265.

Roberts, A. 1985. *Preceramic Occupations Along the North Shore of Lake Ontario*. Ottawa: National Museums of Man, Archaeological Survey of Canada, Mercury Series Paper No. 132.

Roberts, A. 1988. PaleoIndian/Archaic transition on the north shore of Lake Ontario: the lithic evidence. *Bulletin of the Buffalo Society of Natural Sciences*, 33: 281-293

Roberts, A. and P. Julig. 1997. Paleoindian Littoral Adaptations. Paper presented at the Society for American Archaeology, Nashville.

Roberts, A., J.H. McAndrews, V.K. Prest and J.-S. Vincent. 1987a. The Fluted Point People, 9500-8200 BC. In *Historical Atlas of Canada*, edited by R.C. Harris, Plate 2. Toronto: University of Toronto Press

Roberts, A., J.V. Wright, V.K. Prest and J.-S. Vincent. 1987b. The Plano People 8500-6000 BC. In *Historical Atlas of Canada*, edited by R.C. Harris, Plate 5. Toronto: University of Toronto Press.

Roosa, W.B. 1977. Great Lakes Paleoindian: the Parkhill Site, Ontario. *Annals of the New York Academy of Science* 288: 349-354.

Roosa, W.B. and D.B. Deller. 1982. The Parkhill Complex and Eastern Great Lakes Paleo-Indian. *Ontario Archaeology* 37: 3-16.

Stein, J.K. and W.R. Farrand. 1985. Context and Geoarchaeology: an introduction. In *Archaeological Sediment in Context*, edited by J.K. Stein and W.R. Farrand, pp.1-3. Orono: University of Maine, Centre for the Study of Early Man, Institute for Quaternary Studies.

Storck, P.L. 1982. Palaeo Indian settlement patterns associated with the strand-line of glacial Lake Algonquin in Southcentral Ontario. *Canadian Journal of Archaeology* 6: 1-31.

Storck, P.L. 1984a. Research into the Palaeo Indian occupations of Ontario: a review. *Ontario Archaeology* 41: 3-28.

Storck, P.L. 1984b. Glacial Lake Algonquin and early Palaeo Indian settlement patterns on southcentral Ontario. *Archaeology of Eastern North America* 12: 286-298.

Storck, P.J. 1988. Recent Excavations at the Udora site: a Gainey, Clovis occupation site in Southern Ontario. *Current Research in the Pleistocene* 5: 23-24.

Waters, M.R. 1992. *Principles of Geoarchaeology: a North American Perspective*. Tucson: University of Arizona Press.

Willey, G.R. and P. Phillips. 1958. *Method and Theory in Archaeology*. Chicago: University of Chicago Press.

The Sheguiandah Site

Archaeological, geological and paleobotanical studies at a Paleoindian site on Manitoulin Island, Ontario

The Sheguiandah archaeological site is situated on Manitoulin Island, Lake Huron, Ontario. Originally excavated in the early 1950s, the site has remained enigmatic and controversial for half a century. The late Thomas E. Lee discovered the site and recognized its unique value as an ancient cultural deposit, and he succeeded in having the site protected by the Government of Ontario. Lee interpreted his finds as evidence of human occupation that might be older than the last Ice Age, and this claim sparked controversy. In one chapter of this book, Lee's son, Robert, provides a detailed review of the circumstances surrounding the original studies at Sheguiandah.

New studies reported in this book reveal the geological history of Manitoulin Island and the surrounding region, including the bedrock geology and the formation of surface deposits. The complex history of the Great Lakes is viewed from several perspectives ranging from gradually declining lake levels to catastrophic floods. Some chapters reconstruct the evolution of the plant community, while others explore various aspects of the archaeology of the Sheguiandah site. People arrived at the site soon after the glaciers retreated, and they made repeated use of the area for many millennia.

About the Editor

Patrick Julig, a specialist in geological archaeology and lithic studies, is the Chair of the Anthropology Program at Laurentian University in Sudbury where he has been employed since 1990. Following training at the University of Minnesota, York University (B.A., M.A.) and the University of Toronto (Ph.D., 1988), Dr. Julig has also taught at the University of Toronto, York University and Simon Fraser University, and in France. He has conducted archaeological research in the Great Lakes and subarctic regions since 1978, in addition to field work in Sweden, Egypt and Syria.

Mercury Series
Archaeological Survey of Canada
Paper 161

ISBN 0-660-18755-8

9 780660 187556

Canadian Museum of Civilization
Musée canadien des civilisations

Canada